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NOTES ON ROCKALL ISLAND AND BANK, WITH AN ACCOUNT OF THE PETROLOGY OF ROCKALL, AND OF ITS WINDS, CURRENTS, ETC.: WITH REPORTS ON THE ORNITHOLOGY, THE INVERTEBRATE FAUNA OF THE BANK, AND ON ITS PREVIOUS HISTORY.

(PLATES IX. TO XIV.)

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III.

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(Plates IX. to XIV.)

[Read November 30, 1896.]

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I.—Narrative of the Cruise.* (Plates IX., X., XI.)

During the course of the winter of 1895, Mr. R. M. Barrington showed me some correspondence he had had with Mr. Miller Christie and Mr. Harvie-Brown about Rockall, and pointed out the importance of planning an expedition for its exploration. Suggestions were made as to its being a possible site for a meteorological station, its position rendering it admirably

* By Rev. W. Spotswood Green, M.A. (Dubl.), F.R.G.S.

suited for such a purpose, and a station there would, no doubt, greatly assist weather predictions, which would be of great importance to this country. Before any such question could be discussed, a more accurate knowledge of the structure and configuration of the rock was necessary.

The birds frequenting this lonely islet were believed to be interesting; and there seemed to be some chance of a visit to Rockall throwing light on the unsolved mystery which surrounds the life-history of the Great Shearwater, whose nesting place has never, as yet, been discovered.

These problems, together with geological and other considerations connected with this last speck of a lost continent, separated, as it is, from the European plateau by a profound ocean abyss, led us to place our scheme before the Royal Irish Academy, by whom it was warmly espoused. A grant in aid* was made, a committee appointed, consisting of Dr. E. Perceval Wright, Professor A. C. Haddon, Mr. R. M. Barrington, R. Lloyd Praeger, and myself, and plans began to be formed.

It does not seem necessary here to give any historical sketch of the previous explorations of Rockall, that aspect of the subject having been so ably treated by Professor Rupert Jones, in the Report which he has contributed to this Memoir (*postea* p. 89). Nor do I intend to touch, beyond a mere passing reference, on the specimens and observations which are dealt with in the other Reports by those having special knowledge of the subjects with which they are concerned. I shall merely give a narrative of what actually took place in planning and carrying out the expedition.

Having arrived at a general plan of action, the first and most important consideration was how to get to Rockall; for lying, as it does, 240 miles from the Irish coast, away in the stormy North Atlantic, and being, as Capt. Basil Hall described it, the most isolated speck of rock in the world, it was evidently not likely to be a mere yachting trip.

Our thoughts immediately turned to the fine steamer, the S.S. "Granuaile," of about 380 tons gross tonnage, belonging to the Congested Districts Board. She was designed chiefly for cargo work in carrying

* This grant covered about half the expenses: the deficiency was supplied by J. A. Harvie-Brown and R. M. Barrington.

out the work of the Board on the West of Ireland, but is also provided with limited passenger accommodation, and is fitted to combat the wild Atlantic in all its moods. After some correspondence, the Congested Districts Board consented to charter the "Granuaile" to the Academy, for the purposes of the expedition, on as liberal terms as were consistent with the custody of the funds entrusted to that Board's administration.

Some difficulty naturally arose as to fixing a date for departure, the Expedition Committee not wishing to start when the weather might look unfavourable, while the Board's work rendered it necessary that the charter of the vessel should begin on some definite date.

It was urged by those interested in ornithology that June would be more favourable than May; and finally, it was decided that the expedition should start in the first week of June, 1896.

Our party consisted of Mr. J. A. Harvie-Brown, who with Mr. Barrington was to attend to the birds; Mr. Barrington also would collect samples of sea-water, with temperatures, on the voyage; Messrs. R. Lloyd Praeger, W. de Vismes Kane, and H. L. Jamieson should note and preserve specimens of geological or biological interest; and Mr. C. Green came to photograph the rock from as many points as possible. Capt. J. Quirke, of the "Granuaile," and the mate Mr. Rogers, threw themselves energetically into the work devolving on them, and did all that lay in their power to make the expedition a success. And it was pleasant to see the interest which every member of the crew evinced in our work.

I devoted my attention to planning the dredging work, sketching the rock, and having an eye to the general fit out of the expedition.

The outfit for the special services aimed at consisted of two small beam trawls; one Agassiz deep-sea trawl; several dredges, and several hundred fathoms of wire rope; one steel wire sounding-machine; one harpoon gun, with special projectile made like a small grapnel, with 40 fathoms $1\frac{1}{2}$-inch rope, which it was hoped might serve to establish communication and assist us in scaling the rock; one rope-ladder; boxes of jars and bottles for specimens; and two photographic cameras.

On June 3rd, 1896, all our party met on board the "Granuaile" in the snug little harbour of Killybegs. The weather seemed promising,

the wind being from the eastward; and at midnight the anchor was hove up, and we proceeded to sea. Off Rathlin O'Birne, which we passed at 2 a.m., there was a slight heave in the ocean, but, when clear of the land, the sea once more became quite smooth, and we steered N.N.W.

On June 4th, the sun rose red, and quickly disappeared into a bank of cloud, not to show his face any more for that day. At noon there was some swell, and the breeze freshened from the N.E., accompanied by cold drizzling rain. The barometer was all the time rising slowly, which gave us ground for more sanguine hopes, but at 10 p.m. the weather was very thick and dirty, with a heavy sea.

All day long the Fulmar Petrels, which joined us soon after we had lost sight of land, were a constant source of interest, as, with a flight resembling the Albatross, they soared and glided, with every graceful curve, in our wake.

Friday, June 5th.—We sounded at 6.30 a.m., and getting bottom at 130 fathoms knew that we had crossed the great ocean abyss which separates Rockall from the European plateau, and were on the bank. The sea was running high, and the rain driving from E.N.E. obscured all distant view. At 7 a m. we sounded in 80 fathoms, showing that we must be close to the Rock; and at 8 o'clock a sounding of 100 fathoms led us to conclude that we had passed it. We hoped that we might get a glimpse of the sun by which we could fix our position, but our sextants lay idle, and, after some consultation, we decided that there was nothing for it but to "lie to" until the weather should clear. The ship's head was therefore brought round to the north, and we dodged slowly ahead, taking the big seas on our starboard bow, rolling and pitching heavily. It was now blowing a whole gale, which sent the spindrift flying from the sea. We sounded occasionally in depths from 120 to 140 fathoms, and, on getting a bottom of fine sand about 3 p.m., I decided to try a scrape of the trawl, but, in shooting it, the wash of the sea caused it to foul the propeller, and it was so badly torn as to be useless. At 6 p.m. we sighted a ketch-rigged fishing-smack "head reaching" under close reefed canvas; and steaming up as close as we could with safety, we found that she hailed from Shetland, and we asked how the Rock bore from us.

"S.-West" was the answer, but the distance in miles escaped our ears. The ship's head was immediately put about, and we ran a S.-West course before wind and sea. Several Great Shearwaters were seen, which revived the spirits of the ornithologists. Having run twelve miles, we sounded in 75 fathoms; and, as night was closing in, rendering further approach to the Rock and the outlying Helen's Reef dangerous, we lowered an anchor, with 15 fathoms of chain, to act as a drag, and, stopping the engines, drifted to leeward during the hours of darkness. We kept the lead going at intervals; and at daybreak, on June 6th, the captain sighted the rock, bearing S. by E. When I came on deck at 3.30 a.m., we were close up to it, but the first glance set at rest all questions as to the possibility of landing. The little dark, lonely rock, in shape much, resembling a haycock, seemed but a speck in the stormy sea. Girt in seething foam the great swells, as they struck it, sent up single jets of spray, sometimes higher than its summit, and, as they met around its lee and dashed together, completely enclosed it in their embrace. I quickly summoned all the party on deck, and having made a preliminary survey of the main rock and the Hazelwood rock close by, over which the seas broke heavily, we looked out for Helen's Reef. The waves everywhere were crested with foam, which rendered our search somewhat difficult, but when we saw a huge roller break, we were satisfied that we had at last located it definitely. The engines were once more stopped, it being desirable to save coal as much as possible, and we drifted to leeward in the trough of the sea, hoping that, sooner or later, the storm would abate. After breakfast the sun came out, giving us a good chance for photography, so we steamed up again, and took a series of photographs and sketches from various points of view. Some of us closely examined the structure of the rock, while others observed the various species of birds perched on it or swimming on the water close by. The tangle, possibly a Laminarian, which hung like drapery in the foam, with a fringe of green alga above, were objects of interest, but it seemed certain that no land-plant could exist on Rockall.

Drifting away again for about a mile, we sounded in 60 fathoms, and, although the ground was rocky and the sea running high, I decided to

chance a scrape of a large dredge with tangles attached. The dredge was lost, but the tangles brought up some fragments of coral, &c. The remainder of the day was spent steaming slowly to windward and drifting back to leeward, keeping Rockall in sight, and hoping for some change for the better in the weather. Four ketch-rigged fishing-smacks were in sight to the westward, lying to.

When I came on deck before sunrise on June 7th, the sea was breaking around the rock as heavily as ever, and after a few words with the captain, we determined to give up all idea of landing. On consulting the chart, with a view to finding a more promising dredging-ground, a course was laid E. by S. $\frac{1}{2}$ S. When 17 miles had been done, we sounded in 130 fathoms, shot the Agassiz trawl, but, fearing the nature of the ground, hauled it quickly on board. The net was badly torn by coral, fragments of which hung in the meshes. These, with a few starfishes, &c., were the total result of the haul.

We had entertained some idea of including a visit to the interesting St. Kilda group on our return voyage, but, on hearing a report from the engineer on the state of the bunkers, it became evident that we could not undertake any extra distance, and that we had only just enough coal to take us back to Killybegs.

At 10 a.m. we shaped a course for the Donegal coast, and reached Killybegs on the evening of June 8th. The weather became fine as we proceeded south, and Donegal Bay was as calm as the day we left it.

At Killybegs our party broke up—most of us returning to Dublin; but, hoping that a second attempt might be possible, I arranged that all should be ready for a fresh start if the weather was promising on June 13th.

Having settled about the steamer, I got into communication, by wire, with Tory Island, and, through the Meteorological Office, London, with the station on Sumburgh Head, in Shetland, and received bulletins as to the state of the weather. On Friday, the reports from distant stations appeared promising, although, at Killybegs, there was a heavy blow for a few hours on the previous night. Saturday night, however, found us once more on board the "Granuaile," and at 11.30 p.m., the anchor was hove up, and

once more we were steaming a course for Rockall. It was a lovely night, with the sea smooth, barometer at 30″, and light airs from the east. Sunday, June 14th, was a lovely day, and the Fulmars were once more sailing about our track. Until evening everything promised well, and most of the day was spent in preparing gear for the morrow. About 4 p.m., a long, ominous swell began to heave in from the westward, and by the time when we turned in, it was blowing fresh from that point, and the sea was quickly rising.

June 15th.—Sighted Rockall at 4.30 a.m. The wind was blowing strong from the south-west, and the atmosphere was thick and dark with rain. But the most serious matter for observation was, that the sea was breaking heavily around the rock. About 7 a.m., when close up, we watched the point upon which, if the sea were smoother, it would be possible to land, and as the period between the break of each successive wave seemed to offer some chance for a man leaping from the boat, and scrambling up out of the reach of the next billow, we ordered the gear into the gig, and told the crew to get their oilskins and be ready. Immediately afterwards however, the wind shifted more to the westward in a heavy shower, and freshened considerably. The sea quickly rose, so that, when we came on deck after breakfast, the captain decided that the sea was running too heavily to attempt to lower one of the two larger boats; and as the sea, breaking on the rock, offered no hope for the venture being successful, we abandoned the idea, and contented ourselves by circumnavigating the rock as close as we dare take the ship, photographing and sketching it from all points of the compass. This accomplished, we tried once more to dredge something from the rocky bottom in the vicinity, but only with the result of losing another dredge. Then we steamed due south 15 miles, sounded in 100 fathoms, and, finding bottom of fine sand, shot the "Agassiz" trawl, but, fearing further disaster to our nets, made but a short scrape.

In a hawl of about 20 minutes, the water shoaled to 80 fathoms, and when the trawl came up, we found, in the bag, a most unexpected assortment of shallow-water shells, evidently long since dead. Amongst these were several kinds of Pecten, *Venus casina*, *V. fasciata*, *Mytilus modiolus*, &c. How, under present conditions, such shells could be found living anywhere

on the bank was difficult to understand. It would seem to afford the strongest confirmation to the theory that the time is not so very long distant when there was more land, with a shallow coast line, and possibly extensive sand-banks where now the pinnacle of Rockall is the only speck acting as a memorial stone to what tradition has called the "Sunken Land of Buss." After the shallow land-banks had vanished, these mollusks may have accommodated themselves to a deeper sea than is usual for such organisms to live in, and it may be that it is only now that the conditions are becoming too severe for their further existence. There is, of course, the possibility that these shells may have come from the bottom of icebergs which had grounded in Greenland or Spitzbergen bays, but I doubt if in times sufficiently recent such bergs have visited the position occupied by Rockall, and therefore the former theory seems the more probable.

The possibility of the shells having being brought as bait for the lines of the fishing-boats visiting the bank is, I think, disposed of by the mixed character of the deposit, some of the shells being unsuitable for such a purpose. It would be interesting to trace out the area occupied by these dead shells, and, possibly, to search in a similar manner for the lost land of Hy Brassil on the Porcupine Bank, but the time at our disposal only gave us the chance for one dip into this deposit.

Having made another short scrape of the trawl in 110 fathoms, and obtained several species of echinoderms, sponges, corals, and shells, among the latter being some living specimens of *Scaphander lignarius*, we returned once more to Rockall, and steamed slowly around it sketching, observing the birds, and watching one big sea after another breaking into snow-white foam.

Mr. Harvie-Brown shot a couple of Shearwaters, and a Tern; and Mr. Barrington shot a Kittiwake in immature plumage. It seemed such a pity to lose these specimens, that, taking one man with me, I got lowered in the dingey, and, shoving off quickly, to prevent being swamped by the rolling of the ship, we pulled away in search of the dead birds. It was only now we could appreciate the height of the swell, the ship going completely out of sight to the top of her masts when the first sea rose between

her and us; this, too, made it difficult to find the birds, but we picked up one Great Shearwater and the Kittiwake. The others seemed to have been swept in too close to the surge around the rock; we therefore returned to the ship, and were hauled up with no worse experience than a good banging against the side.

Night was now closing in, and the weather, though not bad, was hazy, and the sea lumpy. If the wind would only die down during the night, the sea would quickly follow. We therefore retired to rest, and slept with some hopes for the morrow. Morning dawned on the 16th, and the sun rose bright, but with a stronger south-westerly wind, and a sea as rough as ever. Steaming up as close as we dare, and, bringing the ship's head to sea, we once more lowered the dingey, and I went with two hands to try and, if possible, secure a specimen of the tangle off the rock, but we could not approach the steep face any nearer than 20 yards, for the sea was so disturbed that it was difficult to avoid been sucked in towards the corners of the rock where the sea, every now and then, broke with a loud roar. And, with only one boat in the water, there was no chance of a rescue if any accident occurred. This was our last farewell to Rockall, for, as soon as we were hoisted on board, at 7.40, the ship's head was turned to S.E. by E., and away we went for St. Kilda. Having run 16 miles on this course, we stopped to sound, and, finding promising ground in 120 fathoms, we shot the "Agassiz" trawl. At 11.30 a.m., we hauled it on board, and found that we had a good bag-full of material, consisting largely of sponges, echinoderms, &c., and a few large stones. These things gave Messrs. Praeger and Jamieson a good afternoon's work, while, with a fresh, fair wind, we ran on our course for St. Kilda.

At 4.30 a.m., on June 17th, we let go our anchor at St. Kilda, and, after a visit of a few hours' duration, we left for home. It rained hard while we were on the island, and when we left, the wind suddenly shifted from S.E. to W., and came on to blow. About sunset it was so bad that we sought shelter under Barra Head for the night, and, starting again at daybreak, landed at the Quay in Londonderry the same evening, thus bringing our experiences of Rockall, for the year 1896, to a close.

II.—On the Petrology of Rockall.* (Plate XII.)

So far as I know, no qualified geological observer has ever effected a landing upon this interesting and isolated rock-mass. But through the energetic exertions of Prof. T. Rupert Jones, F.R.S., in his attempts to obtain fresh light upon this remarkable rock, I have been able to study *three* specimens, collected at different times, from the Rockall mass.

The first of these, a very small fragment, appears to be a portion of that collected by Captain Basil Hall, R.N., in the year 1810. This fragment was, about the year 1860, given by Mr. George E. Roberts, clerk to the Geological Society, to Prof. T. Rupert Jones, who has carefully preserved the specimen with the label written for it at the time. This specimen will be referred to as the "Basil-Hall specimen."

The second specimen was collected by Commander Hoskyns, R.N., of H.M.S. "Porcupine," in the year 1862, and sent by him to the late Prof. W. King, of Galway. This specimen is now in the collection of Queen's College, Galway, and was kindly lent for examination and study by Prof. R. J. Anderson. This example, which will be referred to as the "Hoskyns specimen," was probably the one examined and reported upon by the late Mr. David Forbes, F.R.S.†

The third specimen was preserved by Captain Inskip, R.N., who was a lieutenant on the "Porcupine" at the time of its visit. It was handed to me by Prof. T. Rupert Jones, to whom it was lent by the owner. Although it seems to have been mislaid for some years, no doubt can exist as to its having come from the same locality as the other two. This fragment presents some interesting points of difference from the other two, and it will be referred to by me as the "Inskip specimen."

All of these fragments would appear to have been broken from the rock by sailors who effected a landing with considerable risk, the specimens being brought home by the officers of the surveying vessels.

The very interesting drawings and photographs, obtained during

* By Professor J. W. Judd, C.B., LL.D., F.R.S. † Proc. Roy. Soc., 1869, pp. 490–492.

the recent expedition to this Atlantic rock, which have been kindly submitted to me by the Rev. W. S. Green, of the Office of Irish Fisheries, seem to indicate that Rockall is really a portion of a great intrusive sheet of igneous rock, now lying in an inclined position upon stratified masses, which are seen on the south-west side of the rock. The igneous mass shows very marked rectangular jointing, and is thus described by Mr. Green in a note which he has obligingly communicated to me.

"The east face seemed like a great slab of gray granitoid rock (and I was within twenty yards of it) with rectangular joints broken off at the north, so as to show the square edge of another slab, and this was in turn broken off, showing the face of a third." . . . All this granitoid mass "rests, as you suggest, on a rock, showing a kind of bedding or jointing (?), dipping about east, and at an angle of 30° or so."

So far as I know, no specimen has ever been obtained from this underlying mass on the west or south-west of the rock, and it is impossible to say whether it consists of sedimentary materials of stratified tuffs or of some fissile igneous rock. The general relations of the rocks of Rockall strikingly resemble those of the Shiant Isles, North of Skye, where we have the ends of a great inclined sheet of dolerite, resting on stratified clays into which the igneous rock was intruded.

Most observers have agreed that the material composing the greater part of Rockall resembles a "granite," and all three of the specimens I have examined bear out this description. Neither from an inspection of the hand-specimens, nor from the study of thin sections of them, can I find any indication that the rock is of a brecciated or "cataclastic" structure, or that it should be regarded as "an arkose," as was suggested by the late Mr. David Forbes. That excellent observer was probably misled by the drusy character of the specimen he examined; and it is clear that, though he was in the habit of making and studying thin sections for the study of rocks, he could not have employed that method in this instance. I am also unable to detect any traces of foliation in the rock, either in the hand specimens or in the microscopic sections made from them, so that I can find no grounds that would justify my calling the rock "a gneiss," as was suggested by Dr. M. F. Heddle, F.R.S.E.

On the contrary, the material appears to me to be undoubtedly a "massive rock," and one of a new and very interesting type.

The structure of the rock is, to the eye, perfectly granitic; the essential minerals in it being three: colourless quartz, clouded felspar (albite), and black crystals of a ferro-magnesian silicate—soda-augite (ægirine and acmite). The peculiarities of the two latter minerals are not obvious from a megascopic inspection of the rock, and hence it might easily pass as an ordinary granite, or rather as a hornblende granitite, using the last term in the original sense in which it was applied by its author, Gustav Rose.

When the three specimens of the rock are compared, they are found to exhibit a remarkably close agreement in the essential features of their mineralogical constitution, and in their structure the differences are not greater than is often found in different portions of the same rock-mass. In the Basil-Hall and Hoskyns specimens, the granitic (*kornige*) structure is most conspicuous, the quartz, felspar, and augite being all allotriomorphic (xenomorphic). But even in these there is a trace of less perfectly crystallized materials, forming a groundmass to the rocks, so that they approximate to the "granite porphyries" rather than to the true granites. The Inskip specimen, while exhibiting the same minerals in somewhat different proportions to the others, has a distinctly hypocrystalline (hypidiomorphic) groundmass; and a large proportion of the felspars are lath-shaped in section. This variety is at once seen in the hand-specimen to have not only a finer texture but a much darker colour, owing to the excess of the pyroxenic constituent.

The difference of this rock from the other two is just such as is so often seen in parts of a large mass, owing to differentiation. But whether the Inskip specimen owes its peculiarities to having formed part of the edge of the sheet, or from being derived from a so-called contemporaneous vein in it, I am unable to determine. All three of the specimens are somewhat drusy ("miarolitic") in character—in this respect resembling many other rocks of the class of granite porphyries. The drusy cavities are stained with brown decomposition products, indicating, probably, the former presence of secondary minerals within them.

Detailed microscopical study and analysis of the material of Rockall shows that it is as unique in mineralogical and chemical constitution as it is isolated in position. The rock consists of three minerals, a soda-augite (ægirine and acmite), quartz, and albite; accessory minerals, other than magnetite and apatite, appearing to be very rare in it. While the Basil-Hall and Hoskyns specimens approach in character to the soda-granites (*Natron-granit*), and especially to the ægirine granites, differing from them chiefly in the large proportion of the pyroxenic constituent present; the Inskip specimen, by the remarkably large percentage of the latter ingredient, acquires a darker colour, a higher density, and generally a different aspect to that shown in the acid plutonic series. This latter variety evidently finds its nearest analogue in the remarkable "dyke-rocks," classed by Prof. W. G. Brögger, of Christiania, as "grorudites."

In 1888, I insisted strongly on the importance of considering the *quantitative* as well as the *qualitative* mineralogical composition of a rock in assigning it a place in any scheme of classification;* and, more recently, Professor Brögger,† Professor Pirsson,‡ and Mr. Washington§ have laid great stress upon the same consideration. Nowhere do we find more forcible illustration of the importance of this principle than in the remarkable material from Rockall.

There is no difficulty in determining the order of crystallization of the three essential minerals in the rock of Rockall. The soda-augite (ægirine and acmite) was clearly formed first, since we find idiomorphic individuals on which both felspar and quartz are moulded, while needles and small crystals of the green mineral are seen completely enclosed both in the felspar and quartz. In the same way, we find felspar crystals enclosed in quartz; we infer that the albite was the second in order of crystallization, while the quartz was clearly formed after both the other constituent minerals had been crystallized, and it fills in the interspaces between them.

* "The Eruption of Krakatoa."—Phil. Trans., 1888, p. 30, Geological Magazine, dec. 3, vol. v. (1888), p. 1.

† "Die Gesteine der Grorudit-Tinguait-Serie" (1894), p. 92.

‡ Am. Jour. Sc., ser. 3, vol. L. (1895), p. 468.

§ Journal of Geology, vol. iv. (1896), p. 546.

The soda-augite is almost always idiomorphic, even in the most granitic varieties (Basil-Hall and Hoskyns specimens). The centres of the crystals consist of a bright-green ægirine, and the outer portions of the crystals of a brown acmite. In some cases the green and brown portions shade imperceptibly into one another, but in other cases the crystals are beautifully zoned ægirine, showing various tints of green, forming successive shells, the inner usually being of the darkest tint, the whole being enclosed, in turn, by one or more shells of acmite.

The pleochroism of the ægirine is as follows:—

𝔞, Deep grass-green; 𝔟, pale grass-green; 𝔠, yellowish-green.

The absorption is 𝔞 > 𝔟 > 𝔠.

The pleochroism of the acmite:—

𝔞, Pale-brown; 𝔟, yellowish-brown; 𝔠, brownish-yellow.

The absorption is 𝔞 > 𝔟 > 𝔠.

The crystals of ægirine and acmite are sometimes irregularly grown, with quartz in their midst. In the Inskip specimen, the soda-augite tends to form long crystals; and in the midst of the felspar and quartz, as well as in the hypocrystalline groundmass, beautiful needles of ægirine are found in considerable numbers. The ægirine and acmite often show indications of change, especially in the granitic form (Basil-Hall specimen), among the products of change being a soda-hornblende (arfvedsonite), and occasionally one of the blue soda-hornblendes (Riebeckite ?). Further change leads to the formation of various secondary silicates and magnetite.

The phenocrysts of felspar frequently show Carlsbad twinning, and also polysynthetic twinning on the albite plan, more rarely on both the albite and pericline plans. The extinction angles indicate that they belong to the albite series, a conclusion confirmed by analysis. The felspars not unfrequently contain needles, and even larger crystals of ægirine. Usually, the original crystals of felspar are much clouded, and show rounded edges and corroded sides; but in most of these cases a secondary growth of perfectly clear felspar in almost absolute optical continuity with the original crystal has been developed. The quartz has usually grown

round the felspar in such a way as to show that the felspar was formed first; and, indeed, some crystals of felspar are found completely embedded in quartz. In the Inskip specimen lath-shaped crystals form a considerable portion of the mass of felspar, though large phenocrysts also occur. The quartz crystals show no features of special interest. Ægirine needles and small crystals of felspar are enclosed in them.

Apatite needles are by no means uncommon in the rock, and in all cases they are found enclosed in all the minerals, including the ægirine.

I have found no trace of original amphibole in the rock, but arfvedsonite and a blue soda-amphibole are, with magnetite, among the secondary constituents of the rock.

The groundmass, which is present in very small quantities in the Basil-Hall and Hoskyns specimens, consists of lath-shaped felspars (albite) with needles of ægirine and some quartz. This groundmass is present in much larger proportion in the Inskip specimen.

The Inskip specimen differs from the others in the very large proportion of the pyroxenic constituent; hence its darker colour and higher density. A series of careful determinations of specific gravity, made for me by Mr. H. A. Hinton, A.R.C.S., F.G.S., show that the Inskip specimen has a density varying in different fragments examined from 2·92 to 2·94, this being a very high density for a rock so rich in quartz. The Hoskyns specimen he found to have a specific gravity of 2·77, and the Basil-Hall specimen of 2·71. These latter densities are somewhat high for acid rocks of almost perfectly granitic structure; but it must be remembered that, even in these two rocks, the proportion of the ferro-magnesian silicate is higher than is found in most granites. Mr. Hinton found, for specimens of grorudite kindly supplied to me by Professor W. C. Brögger, the specific gravity of the variety near the side of the dyke, and particularly rich in ægirine and arfvedsonite, to be 2·77, while, from the centre of the dyke, which contains less of the ferro-magnesian silicates, the specific gravity was only 2·67.

By the kindness of my colleague, Professor W. A. Tilden, D.SC., F.R.S., I have been supplied with an analysis of the Inskip specimen, which was

made under his supervision in the chemical laboratories of the Royal College of Science, by Mr. C. J. S. Makin. It is as follows:—

	Percentage.
Silica (SiO_2),	73·60
Alumina (Al_2O_3),	4·70
Ferric oxide (Fe_2O_3),	13·10
Manganese oxide (MnO),	·93
Nickel oxide (NiO),	·06
Magnesia (MgO),	·11
Lime (CaO),	·37
Soda (Na_2O),	6·96
Potash (K_2O),	minute trace.
Phosphoric Acid (P_2O_5),	traces.
Total,	99·83

Titanium was not sought for, and the ferrous oxide was not estimated in this analysis.

There are several points of great interest in connexion with this analysis. The low proportion of alumina, the high percentage of ferric oxide, and manganese oxide (in a rock so rich in silica), are remarkable. But especially noteworthy is the high percentage of soda, and the almost entire absence of potash. Nickel oxide, in sensible quantities, has been found in very basic rocks (*e.g.* the dunite of N. Carolina, U. S. A.), but not before, I think, in rocks of so acid a character as that of Rockall. We shall see, however, that some of the peculiarities in chemical composition are accounted for by the exceptional mineralogical constitution of the rock, its poverty in felspar, and its richness in soda-augite. Regarding the whole of the alumina as being contained in the felspar, the analysis represents a rock with the following mineralogical constitution:—

	Percentage.
Ægirine and acmite,	39
Quartz,	38
Albite,	23

(With a little anorthite.)

The ægirine and acmite of the Rockall mass would have the following percentage composition as compared with that of other localities:—

	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)
Silica, . . .	51·97	52·22	49·04	51·74	51·82	50·29
Alumina, . . .	—	0·64	1·80	0·47	0·60	1·68
Ferric oxide, . .	33·48	28·15	29·54	26·17	21·02	25·57
Ferrous oxide, .		5·35	4·82	3·48	8·14	7·68
Manganese oxide, .	2·41	0·54	trace.	0·46	1·00	2·30
Nickel oxide, . .	·20	—	—	—	—	—
Magnesia, . .	·37	1·45	trace.	1·79	1·47	1·55
Lime, . . .	·52	2·19	2·70	5·07	3·01	2·47
Soda, ...	10·97	10·11	13·31	11·02	11·87	8·46
Potash, . . .	—	0·34	trace.	0·34	0·85	—
	99·92	100·99	101·21	100·54	99·78	100·00

(*a*) Is the calculated composition of the ægirine of Rockall.
(*b*) Is the analysis of the ægirine of Kangerdluarsuk by Doelter.
(*c*) Is the same analysed by Lorenzen.
(*d*) The analysis of the ægirine of Breick by Rammelsberg.
(*e*) The analysis of ægirine of the Kola Peninsula by Forsberg.
(*f*) The calculated composition of the ægirine of Grorud by Brögger.

Some of the quartz-pantellerites analysed by Foerstner* seem comparable to the material of Rockall in ultimate chemical composition. The silica, varying between 66·8 and 72·5 per cent., the alumina between 4·8 and 11·5 per cent.; the soda between 5·7 and 7·7 per cent.; and the potash between 0·7 and 0·9 per cent. Some of the quartz ceratophyres have a not dissimilar composition.

In considering the name which should be applied to the interesting material forming Rockall, we are met by some difficulties. Unquestionably, the rock which most nearly resembles it is the grorudite of Brögger (quartz-tinguaite of Rosenbusch). Professor Brögger, who has

* Zeitsch. f. Kr., v., p. 348; and viii. p. 125.

kindly examined a section cut from the Inskip specimen which I sent to him, says:—"The rock, from Rockall, is indubitably closely allied to the grorudites of the Christiania region. The mineral composition is the same, the quantitative proportions of the different minerals probably the same (the chemical composition thence, probably, nearly identical)." He points out, however, that none of the grorudites of the Christiania region have anything like such a coarseness of grain as is exhibited by the rock of Rockall. On the other hand, the natron-granites, to which they approximate in structure, have a much smaller proportion of pyroxene than is seen in the Rockall specimens.

The following analyses will show the comparative composition of the material from Rockall with that of the Norwegian grorudites:—

	(*a*)	(*b*)	(*c*)	(*d*)	(*e*)
Silica,	73·60	74·35	71·35	70·15	66·50
Titanium oxide and Zirconium oxide,	—	—	0·50	0·65	trace.
Alumina,	4·70	8·73	12·21	10·60	10·90
Ferric oxide,	13·10	5·84	4·53	5·77	9·85
Ferrous oxide,		1·00	1·14	2·26	2·34
Manganese oxide,	0·93	0·22	0·78		
Nickel oxide,	0·06	—	—	—	—
Magnesia,	0·11	0·07	trace.	0·35	0·60
Lime,	0·37	0·45	0·22	0·72	0·64
Soda,	6·96	4·51	6·51	5·30	5·56
Potash,	minute tr.	3·96	3·22	4·09	4·54
Phosphoric acid,	traces.	—	—	trace.	0·10
Loss,	—	0·25	0·33	trace.	0·20
Total,	99·83	99·38	100·79	99·89	101·23

(*a*) Is the analysis of the Rockall material (Makins).
(*b*) Grorudite of Varingskollen, S. W. of Hakedalen (Särnström).
(*c*) Grorudite of Kallerud, Svarstad in Lougenthal (L. & V. Schmelck).
(*d*) Grorudite of Grusletton Quarry, near Grorud, middle of dyke (V. Schmelck).
(*e*) Grorudite of Grusletten, near Grorud; side of dyke (L. Schmelck).

It will be interesting to compare the mineralogical constituents of these several rocks:—

	Rockall.	Grorud. Edge of dyke.	Grorud. Middle of dyke.	Varings-kollen.	Kallerud.
Ægirine, ...	39	33·02	22·5	21·6	16·7
Quartz, ...	38	12·26	24	37·5	19·6
Albite, ...	23	29·08	29·5	19·1	44·6
Orthoclase, ...	0	26·88	23·5	21·8	19·1

It will be seen from these data that the Inskip variety of the Rockall material differs so far from Brögger's "grorudite," not only in structure, but in chemical composition and in quantitative mineralogical constitution, that it would be scarcely possible to bring our rock under the same category as his. But if we consider the Basil-Hall and Hoskyns specimens as well, we find that these differ still more widely from the grorudites in structure and composition than does the Inskip variety. Although the creation of new petrological terms is to be deprecated, it is better to take this step than to attempt to extend or modify the accepted definition of a known type. I therefore propose to call the remarkable massive rock of Rockall by the name of *Rockallite*.

Rockallite may be defined as a rock having the structure of the "granite-porphyries" (*hypidiomorphic*, *granular*, and *miarolitic*), but belonging to the extreme variety of the soda-bearing acid rocks. It is an ægirine-quartz-albite rock, intermediate in structure and composition between the soda-granites on the one hand, and the grorudites on the other, and presenting points of analogy with some soda-ceratophyres. Among lavas or effusive rocks, rockallite is probably represented by some of the quartz-pantellerites.

With respect to the age and relations of the rock forming the singular isolated mass of Rockall, the materials for arriving at a judgment must be admitted to be very small. If the rock over which the igneous mass appears to have been thrust could be examined, and especially if it

were shown to be a stratified rock with fossils, the evidence thus afforded would be of great value. At present, however, we have nothing but general analogies to guide us. The nearest resemblance to rockallite is found, as we have seen, among the Post-Silurian dykes in the Christiania district, so admirably investigated by Professor Brögger; and it may be that in Rockall we have a similar intrusive mass of the same period that has escaped destruction by denudation. But it must be remembered that among the Tertiary rocks of the Western Isles of Scotland, in St. Kilda (which is the nearest land to Rockall), in Skye, Ardnamurchan, Mull, and Arran, we have granites and granite-porphyries containing soda-augites and soda-amphiboles. Some rocks approaching very closely in composition to rockallite are known to me among the Tertiary eruptives, and it is therefore by no means impossible that the rockallite belongs to the same recent period.

III.—On Rock Specimens Dredged on the Bank.*

The specimens placed in my hands for determination include two large subangular blocks, and a number of small stones, mostly about 2 centimetres in diameter. They show a remarkable uniformity of character, as if the original source of the material had been true local rock-masses, rather than any ice-drift.

Prof. David Forbes,† on the other hand, recognised a number of granitic and metamorphic rocks among the pebbles dredged between Ireland and Rockall during the cruise of the "Porcupine" in 1869. But these dredgings were made in deep water, at a considerable distance from Rockall itself; and it is noteworthy that the sample from the "Porcupine's" "Station 28," which lies nearest to Rockall Bank, contains a marked predominance of one type of material.

* By Professor Grenville A. J. Cole, M.R.I.A., F.G.S.

† "Notes on Specimens of the Bottom collected during the First Cruise of the 'Porcupine' in 1869."—Proc. Roy. Soc. London, vol. xviii. (1870), p. 491.

In fact, out of a total of thirty-eight stones, dredged up at this station from a depth of 1215 fathoms, nineteen, or 50 per cent., consisted of "volcanic lava." Forbes appears to have classed the different felspars together as "sanadine"; but it is clear that many of his specimens were of basaltic character. Some were very light and vesicular, others were compact and crystalline. He regarded Iceland or Jan Mayen as their probable source.

The recent expedition, however, has revealed a great prevalence of basalt in the neighbourhood of Rockall itself. The specimens gathered by Mr. Cordeaux* from English fishermen who have visited the bank consist, moreover, very largely of basalt.

It is highly probable that the relics of a basaltic plateau lie submerged at Rockall Bank, and that the material of the rock itself represents another phase of local igneous activity.† The bank would find a fitting place in the petrographic province‡ which includes Iceland, the Faröes, the Inner Hebrides, and the north-eastern counties of Ireland; and we must not forget that the whole Cainozoic era has elapsed since vulcanicity was established in this province. Hence there has been ample time for the volcanoes of the Rockall area to be denuded, and for their slopes and lava-fields to be strewn with boulders, large and small. Submergence, I would suggest, has preserved these boulders from further rounding and decay; and, similarly, the metamorphic region on the east has been carried down, with its taluses and stream-courses and moraines, to form the floor of the deep water between Rockall Bank and Ireland.

Sir Archibald Geikie§ has recently dealt with the evidences of submergence in the same volcanic province, from the west of Eigg to Iceland. Hollows that must have been carved out by subaërial denudation now lie far below the sea; while, in Skye and elsewhere, the floor over which the

* See Rupert Jones, *post*, p. 97.

† Compare J. W. Judd, *ante*, p. 48.

‡ J. W. Judd, "On the Gabbros, Dolerites, and Basalts of Tertiary Age in Scotland and Ireland."—Quart. Journ. Geol. Soc. London, vol. xlii. (1886), p. 54.

§ "The Tertiary Basalt-plateaux of North-Western Europe."—Quart. Journ. Geol. Soc. London, vol. lii. (1896), pp. 399–405.

"terrestrial lavas" flowed is now almost entirely concealed beneath the Atlantic. It may be impossible to say how far the great channel of deep water to the east of Rockall is the result of former stream-denudation, or how far it represents a real fold of the Earth's crust. But it is by no means a matter of pure imagination, if we picture its western edge as a scarp of the plateau-basalts, comparable to that of Ireland at the present time, from Belfast to the crags above Dungiven.

The examination of the specimens obtained by dredging has afforded me the following notes:—

1. Boulder, measuring some 25 cm. by 20 cm., "120 fms., 16 miles S.E. by E."

In the mass, this has a finely granular aspect, with small ovoid amygdales, formed of zeolites. The powdered rock, examined under the microscope, shows a ground of some colourless glass, with a zeolitic character in places. Small, well-developed pyroxenes occur, greenish to brownish, and sometimes simply twinned on the orthopinacoid. Certain green chloritic patches seem to have originated in the alteration of this pyroxene. I can trace no olivine; but minute cubes of magnetite abound. Rod-shaped plagioclase occurs freely, and the rock is a typical fine-grained *Basaltic Andesite* or *Basalt*. Many such occur in the Inner Hebrides or in Ireland.

The powder of the rock is magnetic, a character common to all lavas of this type.

2. Boulder, measuring some 20 cm. by 15 cm., from the same station as No. 1.

In the mass, this is of a finer grain than No. 1. It contains similar small zeolitic amygdales. The powder shows small green prisms of pyroxene in a colourless ground, which consists largely of felspar. Magnetite abounds. In thin section, the plagioclase appears fresh, and a palagonitic glass, with globulites, can be detected in the interstices of the crystalline mesh; there is, moreover, a distinct flow-structure, with banding, some of the bands appearing more transparent, and almost colourless, through a predominance of felspar prisms. The contrast between the adjacent bands suggests that this may really be a compound rock, formed

by the parallel intrusion of one basalt in another. The rock may be described as a banded *Basaltic Andesite* or *Basalt.*

3. Three small black fragments, two of them almost angular, from "Second Rockall Expedition, dredged 15th June."

All of these are basaltic lavas, the largest of them being even coarser in grain than No. 1. This specimen exhibits, when powdered, well-marked plagioclase, pale purple-brown pyroxene, magnetite, and some rounded grains, with orange-brown decomposition-products; these grains I regard as olivine. The brown stain arising from them colours some of the pyroxene, and even the felspars, in an irregular fashion. The rock is an *Olivine-Basalt.*

4. A fourth fragment from the same dredging proves also to be a *Basalt* somewhat rich in plagioclase. I can detect no olivine; but the rock is extremely fine in grain.

5. A fifth small fragment, from the same dredging, is a fine-grained *Basalt*, with elongated plagioclase felspars, and signs of flow and banding on a distinctly microscopic scale.

6. From the same station there is a small fragment, fairly rounded, resembling waterlogged pumice. This may well be of distant origin and of modern date. When powdered, its groundmass is seen to be a colourless glass, showing "strain-shadows" between crossed nicols. Some prisms of plagioclase are present, with dark granules, possibly pyroxenic. The rock appears to be an altered *Andesite Pumice.*

7. From "Second Expedition," another dredging. This is a larger specimen than the average, being about 5 cm. by 4 cm., and is scoriaceous, though distinctly heavy. It differs from the other lavas by containing porphyritic glassy felspars, probably similar to those observed by David Forbes. A fragment from one of these felspars, as determined in a diffusion-column of methylene iodide, gives a specific gravity of 2·59. The extinctions of cleavage flakes would refer it to oligoclase; and the penetration of the crystal by the glassy groundmass has probably lowered its specific gravity. The groundmass is dark gray, with zeolites in the vesicles. Under the microscope, the ferro-magnesian constituent remains undeterminable, and is probably represented by minute grains in the glassy ground. Altered

brown palagonitic glass appears between the rods of plagioclase. The rock is clearly an *Andesite*, well removed from the extreme basaltic types.

8. From the same dredging as the large specimens 1 and 2. This is far more rounded than the ordinary specimens from the bank, and may well be of drifted origin. It is a fine-grained gray argillaceous sandstone, with a few flakes of white mica. It strikingly resembles the uniform series of grey-green Ordovician sandstones in the altered strata of county of Down.

Prof. J. W. Judd has kindly given me for description two specimens, with accompanying microscopic sections of rocks, stated to be from Rockall Bank.* These were selected from a number brought by Grimsby fishermen to Mr. Cordeaux, the majority being ordinary basalts. It is clear, however, that the same authority cannot attach to these specimens as to those dredged up by the recent expeditions. One is a good *Granite* of medium grain, quite distinct from the material of Rockall itself. It is red in the mass, and shows, under the microscope, quartz, orthoclase, biotite, apatite, and one or two irregular crystals of brown hornblende. Some of the felspar shows microcline-twinning, and is thus triclinic, while certain of the crystals are intergrown with quartz, forming a delicate micropegmatite, the structure being restricted within the boundary of isolated crystalline grains. A sample of the felspar gave a specific gravity of 2·56.

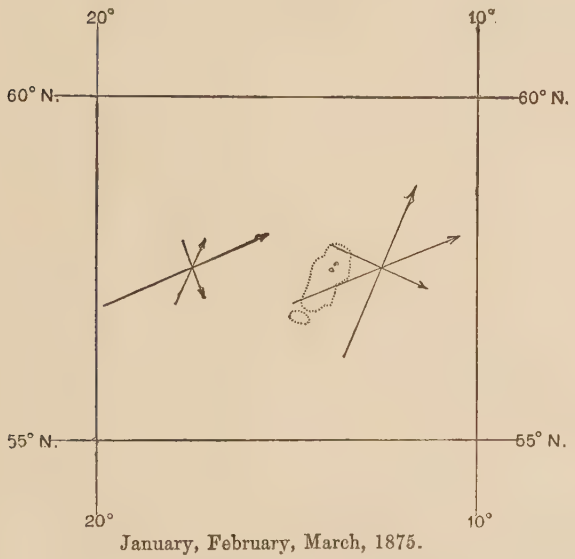
The second specimen is also quite exceptional, and is of a brownish colour. The microscopic slide shows abundant fairly round quartz grains; some similarly rounded grains of felspar, which often show microcline structure; and here and there chloritic patches, fitting themselves in between the other constituents. In addition, there are grains of compact "felsitic" aspect, brown and grey, which I believe to be fragments of other rocks, one, at any rate, being a quartzite. There is a remarkable uniformity in the size of all these grains; and the rock closely resembles specimens from the Torridonian series of Scotland. I may mention that I have specially compared it with the well-known rock of Corry Point, east of Ullapool; and I regard the dredged rock also as a red *Sandstone*.

* See Rupert Jones, *post*, p. 97.

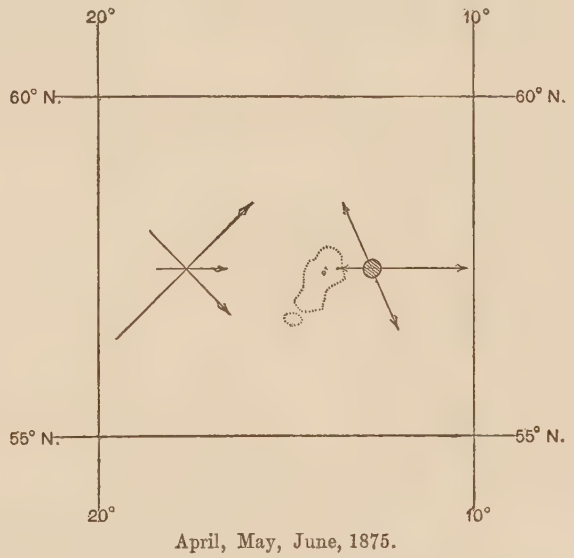
IV.—On the Winds and Currents Charts.* (Plates XIII., XIV.)

I have the pleasure of sending for use in the Rockall inquiries, charts of winds and currents for the district in which that rock occurs.

The currents charts (Plates XIII. and XIV.) are copied from the original charts compiled in this office. The sources of information are the logs of the Mercantile Marine, kept for this office since 1854, and the logs of Her Majesty's ships as far back as 1830. A large amount of



January, February, March, 1875.



April, May, June, 1875.

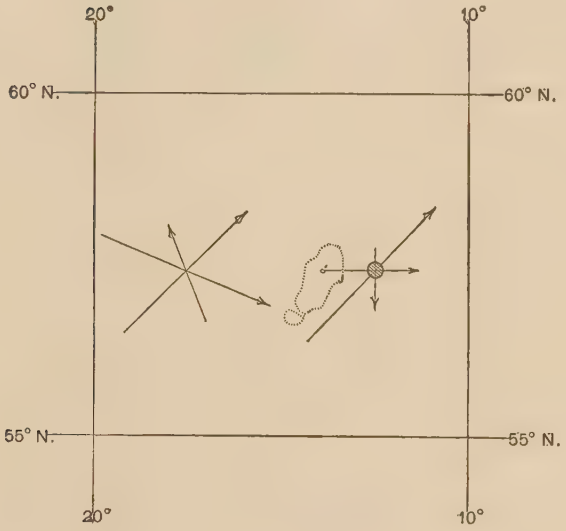
material has also been obtained from private shipowners and from foreign Governments. All available sources of information have been consulted, but if a ship makes more than 240 miles a day, we reject her currents, as she may have passed through more than one current on so long a run.

In reply to the question about the Gulf Stream, it is perfectly well defined up to, say, 50° W. longitude; but, I contend, no further. They say "truth is stranger than fiction." Mr. Dickson has stated to me that, in the Faröe Channel, they had persistent southerly currents, just what is shown on our charts, water coming from the northward.

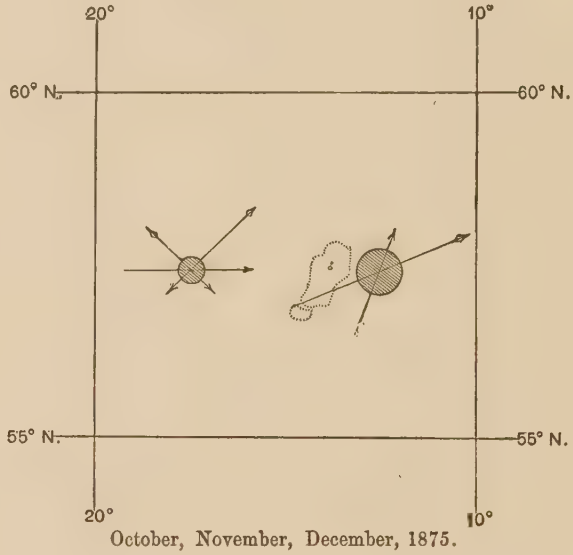
* By Robert H. Scott, LL.D., F.R.S.

The winds have been copied from the Admiralty Pilot Charts, published in 1875. These are four in number, each for three months. The true direction of the wind is shown by an arrow as it flies, the relative duration of the several winds being denoted by the length of the arrow.

Calms are indicated by shaded circles in the central part of the squares, the relative amount for each square being denoted by the size of the circle.



July, August, September, 1875.



October, November, December, 1875.

If a station on Rockall could possibly be established and maintained, its value to weather telegraphy would be incalculable; but there are two or three fearful *ifs*:—

(1). If the place can be built upon;

(2). If the communication by wire can be kept up;

(3). If any one will live there.

V.—On the Salt Water off Rockall.*

I send herewith the results of the examination of the samples collected by Mr. Barrington for me during the expedition. The samples, of course, show a great uniformity, and are not remarkable in themselves; but they are of very considerable interest in relation to samples collected in other parts of the Atlantic, and they will add greatly to the completeness of our charts when we come to draw them.

SAMPLE OF SURFACE-WATER COLLECTED ON BOARD THE S.S. "GRANUAILE" (CAPTAIN QUIRK) DURING THE VOYAGE FROM KILLYBEGS TO ROCKALL.

Oxford Lab. No.	Date.	Hour.	Lat. N.	Long. W.	Temp. °F.	χ.	p from χ.	$_4S_{15}$ Spr.	p Spr.	Diff. from $p\ \chi$.	SO_3.	$\frac{100\ SO_3}{Cl.}$
1	2	3	4	5	6	7	8	9	10	11	12	13
1534	June 14	noon.	55·48	10·40	56·25	19·60	35·41	26·49	35·55	− 0·10	·002297	11·72
1535	,, ,,	4 p.m.	56·17	11·25	55·00	19·57	35·36	..	..	..	..	..
1536	,, ,,	8 p.m.	56·44	12·60	55·00	19·62	35·45	..	..	..	..	..
1537	,, ,,	midnight.	57·10	12·50	53·00	19·60	35·41	..	..	..	·002303	11·75
1538	,, 15	4 a.m.	57·39	13·36	51·25	19·53	35·28	26·27	35·27	+ 0·01	..	..
1539	,, ,,	11.30 a.m.	57·35	13·44	50·75	19·63	35·47	..	..	..	..	..
1540	,, ,,	4 p.m.	57·23	13·27	52·00	19·58	35·38	..	..	..	..	..
1541	,, ,,	8 p.m.	57·35	13·44	51·50	19·53	35·28	..	..	..	·002304	11·80
1542	,, ,,	midnight.	57·32	13·48	51·50	19·63	35·47	..	..	..	..	..
1543	,, 16	4 a.m.	57·35	13·43	50·75	19·56	35·34	26·25	55·25	+ 0·09	..	..
1544	,, ,,	8 a.m.	57·36	13·40	51·00	19·59	35·40	..	..	..	..	..
1545	,, ,,	4.15 p.m.	57·36	12·00	52·70	19·60	35·41	..	..	..	·002302	11·74
1546	,, ,,	8.30 p.m.	57·36	10·50	53·00	19·63	35·47	26·27	35·27	+ 0·20	..	..
1547	,, ,,	midnight.	57·46	9·50	54·00	19·60	35·41	..	..	..	..	..
1548	,, 17	4 a.m.	57·48	8·42	53·75	19·54	35·30	..	..	..	..	..
1549	,, ,,	4 p.m.	57·22	8·16	55·00	19·44	35·12	26·17	35·14	− 0·02	..	..

Cols. 1 to 6 explain themselves.
Col. 7 gives chlorine in grams per kilo of water.
,, 8. Salinity,† *i. e.* total solids per kilo, calculated from col. 7.
,, 9. Density (S − 1) at 15° C. determined by Sprengel tubes, referred to fresh water at 4° C.
Col. 10. Salinity calculated from Col. 9.
,, 11. Diffs. of cols. 8 and 10.
,, 12. Total sulphates—grams SO_3 in 1 gram of water.
,, 13. Col. 12, × 100, and divided by col. 7.

* By H. N. Dickson, Chemical Laboratory, University Museum, Oxford.

† Salinities computed from Table in Twelfth Annual Report of the Fishery Board for Scotland, Part III., p. 381.

VI.—Reports.

ON THE ORNITHOLOGY OF ROCKALL.*

On the Rockall bank 19 species of birds were seen, all marine, save a solitary Dunlin (*Tringa alpina*, Linnæus), and if a Whimbrel (*Numenius phæopus*, Linnæus) be added which was observed 120 miles N.W. of Donegal, we have a list of 20 species to deal with.

The bird population of the Rock itself in June, 1896, consisted, at a rough guess, of about 250 Guillemots (*Uria troile*, Linnæus), 30 Puffins (*Fratercula arctica*, Linnæus), 50 Kittiwakes (*Rissa tridactyla*, Linnæus), immature, 10 Gannets (*Sula bassana*, Linnæus), of which 8 were immature, and possibly 1 or 2 Razorbills (*Alca torda*, Linnæus).

Professor Newton, before the expedition started, wrote to Barrington:—"I do not set up for being a prophet; but so far as I *know*, the Guillemot is the only bird that breeds on Rockall," an opinion which the expedition confirmed, thus putting an end to many suggestions relative to the avi-fauna of this remote island, which imaginative naturalists have from time to time peopled with Little Auks (*Mergulus alle*, Linnæus), Bruennich's Guillemots (*Uria bruennichii*, E. Sabine), and Great Shearwaters (*Puffinus gravis*, O'Reilly), &c. As might be expected, neither of the first two species were seen; but the number of Great Shearwaters (*Puffinus gravis*, O'Reilly) observed, especially near the Rock, and Dr. Gadow's examination of the single specimen obtained,† add to rather than explain the mystery which surrounds its nesting-place. This bird has long been reported to frequent the bank in numbers, and as it is common over a wide area in the North Atlantic, its breeding haunts have for many years afforded a problem, the solution of which ornithologists await with no little interest.

The expedition has proved beyond question that the Great Shearwater (*Puffinus gravis*, O'Reilly) is of frequent occurrence, together with immense flocks of Manx Shearwaters (*Puffinus anglorum*, Temminck), on the Rockall Bank, at all events in the month of June, and that the nearer the Rock is approached the more common the former species becomes (one flock of 40 was seen), and that it nevertheless does not breed on the island. As it possesses the central point of interest in the avi-fauna of Rockall and its banks, its distribution, and all recent observations connected therewith, will be found given in detail under the species. The Fulmar Petrel (*Fulmarus glacialis*, L.) was met with about 30 miles west of Donegal both on our outward and homeward tracks. This species is almost unknown on the Irish coasts in summer, yet it would appear, from our observations and those of the Rev. W. S. Green

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* By J. A. Harvie-Brown, F.R.S.E., F.Z.S., and Richard M. Barrington, LL.B., F.L.S., Members of the British Ornithologists' Union.

† See page 74.

and others during previous years, that it is invariably observed at that season somewhere between 20 and 40 miles from shore off our west coasts even as far south as Kerry.

The comparative absence of immature Gannets (*S. bassana*, Linnæus), and especially of Kittiwakes (*Rissa tridactyla*, Linnæus), from their breeding haunts in June, has been commented on by ornithologists, and it is interesting to note, in connexion with this, that every Kittiwake, without exception, and four-fifths of the Gannets (*S. bassana*, Linnæus), seen over the bank, were immature birds.

It would thus appear probable that the immature birds of these species, in the British Isles at any rate, live far out at sea during the breeding season. Rockall being a wave-swept—or at least spray-swept—rock, absolutely barren of all vegetation above high-water mark save a slimy green alga on its sides, possessing no soil, turf, or *débris* of any kind, and without hole, crack, or fissure of sufficient depth for nesting purposes is a most inhospitable breeding station for birds. The fact that it forms a centre of attraction for that mysterious oceanic wanderer, the Great Shearwater, though this bird does not breed there, will save Rockall from that ornithological oblivion to which this expedition might otherwise have consigned it. Most of the previous information will be found chronologically detailed in "A Vertebrate Fauna of the Outer Hebrides" (Edin. 1888, pp. lxxxvii to xciii), and "Rockall," by J. A. Harvie-Brown (Proc. Royal Phys. Soc., Edin., vol. xiii., pp. 63–72, 1895).

In treating of the species separately, a short account of their oceanic and land distribution, whether breeding on the adjacent lands of Ireland or Scotland, or in more distant localities, or as observed during passage by previous observers, is included, in order to elucidate the mutual relations of this ocean rock with other areas.

The following is a list of the species observed:—

Sula bassana (L.), Gannet.—Ten individuals of this species were resting upon the rock itself, and seen flying around it, and fishing in its immediate vicinity. Of these, only two appeared to be adult; one was in the plumage of the fourth or fifth year, and the remainder in the plumage of the third year. None were seen in the dark plumage of the first and second years. Its nearest breeding station is St. Kilda, 180 miles distant.

Tringa alpina (L.), Dunlin.—About 3 p.m. on the 6th of June, a single bird of this species was observed flying round the ship, at a distance from the rock of from a quarter to half a mile. This can only be looked upon as a straggler. The nearest breeding stations are in the Outer Hebrides, where it is extremely abundant.

It is occasionally seen on passage at St. Kilda and North Rona. It breeds in Iceland, and has been observed nesting, but not abundantly in Faröe, decreasing in numbers, however, towards the N.W., and of doubtful breeding value in Greenland. A few remain to nest in Western Ireland.

Numenius phaeopus (L.), Whimbrel.—On the 3rd of June, about 120 miles N.W. of Ireland, one Whimbrel flew round our vessel and we called him up within shot of the deck. A stiff breeze was blowing at the time from N.E. This bird was evidently a

straggler from a fairly well-defined migration route from S. to N., which lies chiefly along the west coast of Ireland and the Outer Hebrides, where a movement takes place in great force during May and June. A few Whimbrel sometimes remain in Ireland up to the end of June, but they have never been observed nesting there. It is occasionally found paired, and probably breeding on N. Rona, and is abundant in Faröe and Iceland, and occasionally in Greenland.

Sterna minuta (L.), Lesser Tern.—It was curious to find one of this species so far out of its beaten tracks. One was shot by Barrington from the deck of the "Granuaile" on June 15th, when close to the rock. Its nearest breeding haunts are on the Island of Tiree, one of the Inner Hebrides, and in Donegal and Mayo, but it is far from abundant, and the smallness of its numbers is suggestive of a more eastern distribution. In Scotland its breeding quarters in the west are few and far between, while it is absent from north-western localities.

Sterna.—(?) Arctic or Common Tern.—A Tern belonging to either one or other of these species was seen close to the Rock shortly after the Lesser Tern was shot, but not near enough for actual identification.

The Arctic Tern at present is the commoner nesting species in the Outer Hebrides and on the west coast of Scotland, although the Common Tern (*S. fluviatilis*, Naumann) seems to be the more assertive. In Ireland both species breed in company on the islands off the coast, but the Arctic Tern rarely breeds on inland lakes like the common species. Both breed in Greenland, the Arctic Tern being predominant (Hagerup). In Iceland, the Common Tern is only a straggler and rare, if indeed it has ever occurred (Newton, 1863); nor does it occur in Shetland or Faröe. We cannot, therefore, expect its occurrence on migration past Rockall. Terns were seen near the vessel on the 4th of June, at 7 a.m., but the species was not identified.

Larus fuscus (L.), Lesser Black-backed Gull.—An immature gull observed near the Rock may have belonged to this species. With this exception, none were seen at any distance of more than forty miles from land either off the Irish or Scotch coasts, on both of which it breeds in considerable numbers. Its appearance was almost coincident with the disappearance of the Fulmar on our return journeys to the Irish coast.

Larus argentatus (J. F. Gmelin), Herring Gull.—None were identified at or around the Rock, but at 12 noon on June 13th, when 90 miles from Ireland, 130 miles from Barra Head, and 145 miles from St. Kilda, on our course for Rockall, five Herring Gulls followed in the wake of our ship, of which three were adult and two were immature.

Larus canus (L.), Common Gull.—This species was not seen until we were passing about two points of the compass west of the lighthouse of Skerryvore, on our return course from Barra Head to Ireland on June 18th, when a flock of about forty followed the ship for a time, and then left us, flying nearly due north.

Rissa tridactyla (L.), Kittiwake Gull.—The most remarkable note regarding this species is, that, without exception, all the examples seen, whether resting on the Rock, flying around

the banks, or observed after 50 miles from land, were immature birds. On approaching the Rock we became perfectly satisfied that there was not one adult Kittiwake to be seen, and none were breeding. One was noticed carrying in its bill, to the Rock, a long shred of *ship's-waste*, but, watched carefully until it alighted, the binoculars clearly demonstrated that it was likewise an immature example. When compared with other species of British Laridæ, the almost total disappearance of immature Kittiwakes from our coasts in the breeding season is remarkable ; our experiences during the Rockall expedition prove that numbers of the young birds are oceanic in their habits, at least during the month of June. Kittiwakes were met with in the month of October, during the homeward voyage of H.M.S. "Alert" off the coast of Greenland, all the way across the Atlantic, in greater or less abundance, and are specially noted as "numerous" on 23rd October, 1876, in lat. 53° 59′ N., long. 23° 5′ W. ; and "many" on 22nd October, 1876, in lat. 54° 5′ N., long. 24° 55′ W.*

Stercorarius catarrhactes (L.), Great Skua.—Only one was seen when about a mile from Rockall, at 8.30 a.m. on June 15th. It passed astern of the vessel, and pursued a course to N.E. This specimen may be looked upon as a late migrant. The Great Skua nests in Shetland, Faröe, and Iceland, but has not been recorded as breeding in Greenland. Its migration routes have not been ascertained but they are probably oceanic. It is the rarest of all the Skuas in Ireland, occurring chiefly in the autumn. Along the New England cod-bank it is familiarly known as the "Sea Hen" (Captain Collins, *vide* foot-note, p. 72).

Stercorarius pomatorhinus (Temminck), Pomatorhine Skua.—Now and then a single bird passed the ship, going chiefly towards the north. Most of them were seen when we were over the bank, or dodging near the Rock. On one occasion, June 5th, four were observed; but during our second visit, June 13th to 17th, none were seen, either of this species or of Buffon's Skua. It is possible that we passed through a line of late (?) migrants of these species in the beginning of June.

The Pomatorhine Skua has been occasionally observed in Iceland and Faröe, and is a comparatively rare visitor to the N. coasts of Europe, but is found nesting in Greenland, and in Arctic America and Siberia, and on migration has been observed passing over the New England cod-banks.

Harvie-Brown has met with it abundantly in some seasons when yachting off the Outer Hebrides between Lewis and the Flannan Isles, and also within the waters of the Inner Hebrides. Its line of migration may deviate considerably according to prevailing winds or currents, and drift of food supplies. It is a regular autumnal visitor to the Irish coasts, usually seen in October (More).

Stercorarius parasiticus (L.), Buffon's Skua.—We first observed a specimen of this species near the Rock on the 6th of June, and afterwards a few other solitary birds; but on the 7th, at 2.30 p.m., six were seen together when on our course back to Killybegs, circling round the ship for a time, but never coming very near, and then making off in a N.E. direction.

Harvie-Brown has met with the present species on a few occasions, almost in midsummer,

* Col. Feilden's Chart of return voyage of the "Alert" across the Atlantic, *in lit.*—J. A. H.-B.

nearer to the mainland of Scotland. Buffon's Skua has been observed, but does not breed, in Iceland; but it nests in Greenland, Northern Scandinavia, Finland, and Novaja Zemlya. It is well known to the cod-liners of the American coast, taking toll of the other birds, or feeding independently upon the refuse and cod-livers thrown out by the crews of the vessels.

Stercorarius crepidatus (J. F. Gmelin), Arctic Skua.—Save one doubtfully recognised near the Rock on the 5th of June, none were seen on our first visit; but six—one dark and five light-coloured—were seen close to the Rock on June 16th, and a few were met with again between Barra Head and Ireland on our return course from St. Kilda, on the 18th. These Skuas were certainly less abundant on this outside route than either the Pomatorhine or Buffon's Skuas.

This Skua breeds commonly in the Outer Hebrides and on several of the islands of the inner group, and in the Orkney and Shetland Isles, Faröe, Iceland, Northern Scandinavia and European Russia. It is a regular autumn visitor, and the commonest of the Skuas on the Irish coast, and has occurred, though less frequently, in spring. (More.)

Alca torda (L.), Razorbill.—Except when close to the cliffs of N. W. Donegal, and when the "Granuaile" was approaching or leaving the land, few Razorbills were seen. At Rockall it was decidedly rare. Only one bird was identified, and this was at a time when a good opportunity was afforded of scrutinizing the flocks of Guillemots and other birds which passed alongside the steamer or overhead. The Razorbill is less abundant in Faröe than the Guillemot, and is not quite so common in Iceland as the two species of Guillemots, *Uria troile* and *U. bruennichii*. It has not been found breeding anywhere eastward of the northern coast of Scandinavia.

Uria troile (L.), Guillemot.—At least 200 to 250 Guillemots occupied the only ledge on which they could breed. This runs round about two-thirds of the rock just below the peaked summit. The most densely populated portion, and the broadest and most level part of the ledge is on the south side. Guillemots almost monopolise the ledge; but here and there, apart from them, a few Puffins were perched, and a Gannet or two occasionally alighted close beside them. When a fowling-piece and the harpoon gun were discharged, the Guillemots showered down off their ledge. We were near enough to see their heads and bills when sitting, yet not an egg was observed to fall into the water by any of the party. Harvie Brown has, however, received Guillemot's eggs, *said* to have been taken on Rockall by Captain Leo, of the "Great Surprise," Grimsby smack, about 1888. Apart from this, there is no *direct* evidence to prove that the Guillemot breeds there; but, having regard to the numbers seen by us on the ledge, we consider it probable. No specimens with the white eye-streak, the so-called *U. lacrymans*, were identified. This bridled variety appears to be a northern type, and in its distribution, more easterly than westerly. Its numbers increase towards the north of Scotland and in the Faröes, but become scarcer in Greenland and possibly also in Iceland. Professor Newton says, however, that in Iceland it "occurs in about the same uncertain proportions as it does in other countries." It has been suggested that Bruennich's Guillemot might be found on Rockall, but it was not observed, and the occurrence of this northern species so ar south is most improbable.

Fratercula arctica (L.), Puffin.—We saw about 30 Puffins, some of them sitting in holes

apparently caused by weathering on the perpendicular face of the rock, but only resting and not breeding there, the holes being unsuitable for that purpose. Within a radius of one mile from the rock, single birds and occasionally groups of half-a-dozen were observed scattered here and there. Very few were seen when passing over the deeper soundings.

Fulmarus glacialis (L.), Fulmar.—The Fulmar was first seen about 30 miles from Donegal, on the 4th of June, and about two to six individuals were in constant attendance on the vessel, especially at meal-times. When 120 miles out, thirteen Fulmars and three Stormy Petrels were in sight at the same moment. On approaching the Rock, there was no appreciable increase in the number of Fulmars; but, on the second expedition, when we were over the banks, as many as twenty were attracted by baits on floating fish-hooks. For these the birds quarrelled; but, notwithstanding their eagerness, the bait was always taken safely off the hook, and not a single specimen was caught.

The Rev. W. S. Green informs us that, in summer time, the Fulmar is generally met with about thirty miles off the west coast of Ireland; but otherwise, it is only a rare and accidental autumn or winter visitor, generally driven inshore in bad weather. When a ship is approaching land the Fulmar follows it in further than its usual limit.

On our return journey, they followed us to within 20 miles of the Derry coast. The nearest breeding haunt to Rockall is St. Kilda, where, as is well-known, it is the conspicuous species. It has established colonies within recent years on Foula, in Shetland, and N. Rona, and is increasing on the Faröe Islands. We failed to detect any marked differences in the plumages of the birds during the Rockall expedition; and Harvie-Brown only once observed such differences, *i.e.* in June, 1894, between Sumburgh Head, and Thorshaven. Barrington, in 1892, questioned the inhabitants of Mygenaes, in Faröe, on the point, and they declared that any marked difference in the plumage of the Fulmar was of the rarest occurrence there.

Puffinus gravis (O'Reilly), Great Shearwater.—Few oceanic birds have a wider range over the Atlantic, yet its nesting-place is wrapped in mystery. It extends from Greenland to 65° 30′ N. lat. (Holboll), and appears in vast numbers off the New England fishing-banks, and reaches across the Atlantic to the British seas. It occurs in numbers on the Faröe Banks, and extends northwards to Iceland, and eastwards to N. Norway, and has occurred once or twice in Heligoland (Gatke). Swinburne met with them between 40°–45° S. lat. in swarms "so dense that he at one time mistook them for land" (Proc. Roy. Phys. Soc. Edin., ix., p. 196, 1886).

Its eggs are unknown ("Arctic Manual," 1875), (Howard Saunder's "Manual of Brit. Birds," 1889). Audubon suggests its breeding on the coasts of Nova Scotia or Labrador ("Orn. Biog.," vol. iii., p. 555); and Nuttall records "supposed eggs from Greenland" (2nd ed., 1894). Seebohm says: "it breeds in the Azores, and must not be confounded with *P. kuhli*," and he believes it breeds in Greenland. We have utterly failed to find his authority for the statement. Payne-Gallwey gives some evidence ("Fowler in Ireland," p. 289) that it breeds in the Blaskets off Kerry, but the evidence is quite insufficient.

Returning from Nares' Arctic Expedition in October, 1876, Colonel Feilden saw the

first specimen of *P. gravis* about the 55° parallel of N. lat. and 40° meridian W. of Greenwich. They were seen most abundantly on and after the 21st October, in lat. 54° 24′ N. and long. 30° 3′ W. to lat. 53° 15′ N. and long. 13° 3′ W. only leaving the track of the vessel a few miles outside of Valentia on October 27th.

It is called the "Hagdon" or "Hagdown" both by cod-fishers off the New England Banks, where it is used as bait (Collins),* and by the fishermen on the W. coast of Ireland (Saunders). Captain Collins states that the Hagdon arrives on the fishing banks of the E. American coast in the latter part of May, on the 29th (lat. 43° 35′ N., and long. 59° 47′ W.); "several large flocks were sitting on the water, and had apparently just reached the locality. Occasionally they seem to be scarce in midsummer." Collins suggests that they breed in winter: "having opened many hundreds of these birds, he has never found their sexual organs in a condition that would indicate that they were incubating." Captain Collins' description of its habits—resting on the water, and *not* apparently feeding, on its first arrival—coincides with our observations at Rockall. He says their chief food is the squid.

Many records occur of its appearance upon our coasts, but more especially upon the coasts of Devon and Cornwall, dating back to 1874. (Gatcombe, Zool., 2nd ser., 1874, p. 4202; Bridlington Bay, Gurney, *loc. cit.*, pp. 3882–83: and Rodd, *loc. cit.*, pp. 4261–62.

In 1875 large numbers are recorded off the coasts of Devon and Cornwall, *loc. cit.*, Jan., 1875, p. 4300 (Gatcombe). Not until 1894 have we any account of its occurrence in large numbers in the seas off the west of the Hebrides, and north of the Butt of Lewis and North Rona.

Professor Newton, *in lit.* to Barrington, June 27th, 1896, says that, when on his way to the Faröes in 1894, he saw a great many, chiefly in pairs off the Butt of Lewis, as if about to nest, but that they disappeared as he approached N. Rona. [The birds were *not* going in pairs on the Rockall Bank in 1896.] On June 24, 1895, he counted 50 between Barra Head and St. Kilda, but on the 27th saw none between Stornoway and the Faröes.

In 1896, between June 19th and 24th, none were observed by him when cruising among and outside the Hebrides, nor afterwards up to July 7th, the interval being occupied on a voyage to Shetland and Orkney, and subsequently to St. Kilda.

Mr. Hugh L. Popham, in 1894, met with numerous Great Shearwaters to the north of N. Rona, about two days later than Professor Newton saw them. Mr. Popham does not believe that the Great Shearwater had any intention of breeding, and it did not strike him that they were in pairs. Mr. H. L. Popham says: "There were no young birds amongst them, but the old birds could hardly fly, having apparently moulted out their primaries!!"

Professor Newton, speaking of their possibly breeding on the Outer Hebrides refers to the general difficulty of finding the nesting holes of any species of Shearwater, and quotes the

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* "Notes on the habits and methods of capture of various species of sea birds that occur on the Fishing Banks of the Eastern coasts of N. America, and which are used as bait for catching cod-fish by New England Fishermen."—Report of Commissioner of Fish and Fisheries (1882). Smith Misc. 46–21, 22. [1], 311–335. Collins.

experiences of his brother in the Mauritius, when searching for those of *P. chlororhynchus*. We think all our data, so far, go to prove that the birds which frequent our seas are but wanderers over the North Atlantic for feeding purposes. Professor Newton thinks that it is only of late years that they have appeared in our seas; in this Harvie-Brown is inclined to acquiesce. He has visited the Outer and Inner Hebrides, and also navigated those seas off and on since 1870, and in 1891 he circumnavigated the Shetland Isles; and in all that time he only once or twice saw any other species except *P. anglorum*, and that was close to Eigg.

During the progress of inquiries now being instituted in oceanography over the North Atlantic and in the relative distribution of marine life in warm and cold, deep and shallow areas of sea, there can be little doubt that more light will be thrown upon the habits, life-history, food, and distribution of many ocean birds, the present species included.* But the distribution of the Great Shearwater *appears* to be independent of these hot and cold currents.

Before arriving on the banks we had not seen a single Great Shearwater; but on the evening of the 4th of June we met with a great many of these birds for the first time since leaving Killybegs, and afterwards, whilst in the neighbourhood of the Rock, we continued to meet with them, either singly or in flocks, apart from, or mingling with vast flocks of Manx Shearwaters. Jameson, on one occasion, counted sixteen in one flock, unaccompanied by any of the smaller blacker-plumaged species; and on the second expedition, Barrington saw a flock of, at least, forty Great Shearwaters within half a mile of Rockall. Only two or three were seen off the banks when on our course for St. Kilda. Between Barra Head and the Irish coast a few were noted, and two were observed within twenty miles of the north coast of Derry. They seldom, if ever, went in pairs. This, as will be seen, is somewhat opposed to the experiences of Prof. Newton and Mr. Henry Evans when they met with them nearer to the Scottish coast in 1894. Returning homeward, the Great Shearwater left us when near the edge of the bank, which appears to be a feeding- and resting-ground of the two species.

Captain Ed. Freshwater, of the "Undine," says he landed on Rockall in the year 1887, and produced a rough sketch of the rock to Mr. John Cordeaux.† He describes the birds on it as very numerous, and as "Rockall Lires" or "Lyres." "These are most numerous of any," and "black above, white below." He had never seen these birds anywhere in the north seas except here and on the Faröe Bank; and he gives a list of the birds frequenting the Rock, thus:—"1. Rockall Lyres; 2. Willocks (Guillemot); 3. Tommie Nories, or Greenland Puffins (= Puffin, *Fratercula arctica*); 4. Kittiwakes; 5 Gans (Gannet); 6 other Gulls; and probably Fulmars. The Faröese men occasionally land and take young birds for bait!"

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* "The Relations of the Gulf-stream and the Labrador Current" (Report of the Sixth International Geographical Congress, London, 1895, by Dr. Sibbey). This is a suggestive paper.

† "No Grimsby smacks landed their crews on Rockall in 1896."—Cordeaux, *in lit.*, 1st July, 1896. He now believes that many stories of fishing-vessels landing their crews in other years are without foundation, but see Consul Bergh's letter, *infra*, p. 76.

On our second visit, the Great Shearwaters were met with sparingly, save close to the Rock. On June 14th, 120 miles from Killybegs, four were seen. At 3 a.m. on the 15th, before sighting the rock, our captain said that the "Granuaile" steamed through hundreds of Shearwaters of sorts. Within half-a-cable of Rockall, a large flock of Manx Shearwaters was met with, and amongst them a sprinkling of *P. gravis*. Harvie-Brown shot two of the latter, and Green, in the "dingey," succeeded in recovering one of them. This bird was apparently moulting, having many feathers in various stages of growth. It was skinned by Williams, of Dublin, and its body, preserved in spirits, forwarded to Professor Newton, of Cambridge, who submitted it for dissection to Dr. Gadow. The latter gentleman reports:—

"University Museum of Zoology, Cambridge,
"*October* 15*th*, 1896.

"Dear Professor Newton,

"The body of the bird * procured by the Rockall Expedition, 1896, and handed over to me as that of a Great Shearwater, is that of a female, apparently adult. The condition of the ovary and of the oviduct show, without doubt, that this bird has not laid any eggs, nor was it going to breed, within this year.

(Signed) "H. Gadow."

Although as small islets as Rockall have been known to be inhabited by allied species (see Feilden: "On the breeding of *Puffinis auduboni* in the Island of Barbadoes," Ibis, 1889, pp. 60–63), yet a great deal depends on the locality. The "Bird Rock" of Barbadoes, having its summit "clad in green, and with a large blossoming pink Ipomœa," presents a very different aspect from our barren and storm-swept Rockall. Feilden says the eggs of *P. auduboni* were deeply incubated on the 25th March, 1889. We think it to be a physical impossibility for the Great Shearwater to find nesting accommodation upon Rockall.

Puffinus anglorum (Temminck), Manx Shearwater. The account of our experiences of this species has been unavoidably associated with that of the larger or rarer species, and there remains very little for us to add, except that *P. anglorum* was more general in its distribution, and perhaps fifty times more abundant. Their habits appeared to be very similar. Those seen over the deep soundings were *roving*, those over the shallow soundings were *massed* together and *resting* on the water until disturbed. They were feeding or sleeping. These concourses of Shearwaters close to Rockall were probably frequenting old and long-used fishing-grounds.

The nearest breeding haunts of the Manx Shearwater are in St. Kilda, 187 miles to the eastward, and they nest abundantly in Eigg, the Garveloch Isles, and in other parts of the Outer and Inner Hebrides, as well as on the Donegal coasts. We cannot doubt their ability to fly daily to and from the shores of the Hebrides or Ireland, but Barrington considers this unlikely.

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* This specimen, with those of the Invertebrates collected, have been presented by the Royal Irish Academy to the Science and Art Museum, Dublin, Natural History Department.

[*Puffinus griseus* (J. F. Gmelin), Sooty Shearwater. About twenty miles N.W. of Donegal, on the 18th of June, Jameson drew our attention to a bird which may have been of this species.]

Procellaria pelagica (Linnæus) Stormy Petrel. Over the deep seas, single birds or at most three together were seen, but never coming near nor following our ship. The largest number noticed together in shallower water was seven, and this was not more than fifteen miles off the north Donegal coast. On the Rockall banks they were rarely observed. Once or twice what may have been examples of the allied Fork-tailed Petrel were seen, the flight less butterfly-like than that of the Stormy Petrel, and the appearance of the bodies longer, but we could not identify them with certainty. Harvie-Brown has elsewhere* described the flight of both species as observed at close quarters.

Since the completion of the above Report the following letter has been kindly forwarded to us by Mr. Robert H. Scott :—

[Translation.]

"The Meteorological Institute of Denmark,
"Copenhagen, *15th April, 1897.*

"Dear Sir and Colleague,

"A friend of mine, Consul Bergh of Thorshaven, has given me the following information about landing on Rockall. The *Dimmalaetning* (a daily paper of Thorshaven) of August 6th, 1887, records that Daniel Davidson, of Naas, first mate of the sloop 'Dolphin,' and John Mathias Peterson, fisherman on the sloop 'Gauntlet,' had climbed Rockall in the previous month (July, 1887). They found a large number of sea-birds; every spot which afforded a place for a nest was occupied. The birds were very tame, so that they could be caught by hand. D. Davidson informed Consul Bergh that the crag was full of cracks, that the height was 4 (*sic*) fathoms, and its circumference was 35 fathoms (both these measurements were taken with a line). The island was absolutely bare of vegetation. The ascent lay on the north or north-westerly side. In May, 1888, Daniel again ascended the rock, this time with his brother Ole.

"In a paper by J. A. Harvie-Brown, at p. 69, it is asserted that Captain J. Hansen of Thorshaven was at Rockall in 1887. Consul Bergh has written to inform me that this is not correct. Captain Hansen and Consul Bergh both reside at Thorshaven, the latter writes that Captain Hansen has never landed on Rockall; and 'we could never have,' so writes Captain Hansen, 'attempted it, because neither he nor any other ship's captain dare bring his ship near such a dangerous place.'

"This is all the information about Rockall which I have been able to procure for you.

"Yours very truly,

"Adam Paulsen.

"*To* R. H. Scott, LL.D., F.R.S.,
"*Director, Meteorological Office, London.*"

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* "A Vertebrate Fauna of the Outer Hebrides," p. 7, and "A Vertebrate Fauna of Argyll and the Inner Hebrides," p. 197, by J. A. Harvie-Brown and T. E. Buckley.

ON THE MOLLUSCA.*

The following species of Mollusca are represented by the specimens obtained in this Expedition :—

Anomia patelliformis, Linné. 100 fathoms.
Pecten islandicus, Müller. 100 fathoms. Two valves, probably semi-fossil, one of which, however, has a recent appearance.
Pecten tigrinus, Müller. 100 fathoms. Two valves.
Pecten striatus, Müller. 120 fathoms. A living specimen, with valves slightly broken at hinge.
Lima loscombii, G. B. Sowerby. 100 fathoms. One valve and portions of two others.
Mytilus modiolus, Linné. 100 fathoms. Dead valves.
Cardium echinatum, Linné. One valve.
Astarte sulcata, Da Costa. 190 fathoms. Dead valves.
Venus lincta, Pulteney. 100 fathoms. Single valves.
Venus casina, Linné. 100 fathoms. Three left valves, dead.
Venus fasciata, Da Costa. 100 fathoms. One valve.
Mactra solida, Linné, var. *elliptica*. 100 fathoms. Single valve.
Thracia papyracea, Poli, var. *villosiuscula*. 100 fathoms. Portion of a right valve.
Mya truncata, Linné. 100 fathoms. Portions of valves, dead.
Saxicava rugosa, Linné, var. *arctica*. One specimen, with the two valves united, and single valves.
Trochus millegranus, Philippi. 120 fathoms. A dead specimen.
Buccinum undatum, Linné. 100 fathoms. A broken shell.
Buccinopsis dalei, J. Sowerby. 120 fathoms. Two dead shells.
Scaphander lignarius, Linné. 120 fathoms. Seven living specimens.
Clio pyramidata, Linné. Three living specimens in the tow net.

It will be observed that nearly all the specimens were single valves, or portions of valves. Most of the species have an extensive distribution in the North Atlantic ; but *Pecten islandicus*, *Mytilus modiolus*, and *Buccinopsis dalei* are decidedly northern forms. *Pecten islandicus* is not found living now south of Norway, but dead valves in a semi-fossil state are sometimes dredged off the coasts of Scotland and the Shetland Isles. *Mytilus modiolus* does not range further south than the west coast of France, and *Buccinopsis dalei* is not found south of the English Channel.

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* By A. R. Nichols, Science and Art Museum, Dublin.

BRACHIOPODA.

Terebratula caput-serpentis, Linné. A young living specimen.
Terebratula cranium, Müller. 100 fathoms. Portion of valve.
Rhynchonella psittacea, Chemnitz. 100 fathoms. Portion of valve; probably semi-fossil.
Crania anomala, Müller. 120 fathoms. Upper valve of a young specimen.

As in the case of the Mollusca, the specimens dredged consisted principally of single valves and portions of valves. *Terebratula caput-serpentis* and *Crania anomala* have an extensive distribution in the North Atlantic; *Terebratula cranium* is a Northern form which has, however, been dredged in deep water off the west coast of Ireland, and southwards; and *Rhynchonella psittacea* is an Arctic species not known now to be living south of Norway, although dead specimens and single valves have been dredged as far south as off the coast of Suffolk.

ON THE CRUSTACEA.*

DECAPODA.

Ebalia nuz, Norm.
Eupagurus pubescens (Kroy).
Pandalus leptorhynchus (Kinahan) ? Sars.
Pandalus montagui, Leech.
Galathea dispersa, Bate (?) juv.

AMPHIPODA.

Hyperoche tauriformis (Bate), (*H. kroyeri*, Sars.).

COPEPODA.

Caligus curtus, Mull (*C. mülleri*, L.).
Anchorella, sp.

CIRRIPEDIA.

Scalpellum regium, Wy. Th.
,, *stroemii*, Sars.
Balanus tintinnabulum.
Verruca stroemii, O. M.

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* By W. T. CALMAN, B. Sc., and E. P. WRIGHT, M.D.

ON THE CHÆTOPODA.*

Polychæta.

Lætmonice filicornis, Kinb.
Hyalinœcia tubicola (O. F. Müll.)
Haplosyllis hamata, Clapde. (?) In tissue of sponge.
Castalia punctata, O. F. M.
Chætopterus (?).
Terebella (*Nicolea*) *zostericola*, Orst.
Serpula vermicularis L.
Hydroides norvegica, Gunn. Fragment of tube.
Placostegus tridentatus, J. C. Fabr. Fragment.
Evarne, sp. (?)

There is not much of interest in the collection, unless the species of *Evarne* may prove to be rare.

ON THE ECHINODERMATA.†

I.—Crinoidea.

1. *Antedon rosacea* (Luick).

II.—Asteroidea.

1. *Pontaster tenuispinus* (Düben and Koren), Sladen.
2. *Plutonaster* (*Tethyaster*) *parelii* (Düben and Koren), Sladen.
3. *Astropecten irregularis*, Linck.
4. *Luidia sarsii*, Düben and Koren.
5. *Hippasteria plana* (Linck), Gray.
6. *Stichaster roseus* (O. F. Müller), Sars.
7. *Cribrella sanguinolenta* (O. F. M.), Lütken.

III.—Ophiuroidea.

1. *Ophioglypha sarsii* (Lütken), Lyman.
2. *Ophiopholis aculeata* (Linn.), Gray.
3. *Ophiactis ballii* (Thompson), Lyman.
4. *Ophiothrix fragilis* (O. F. M.), M. and T.

IV.—Echinoidea.

1. *Dorocidaris papillata* (Leske), A. Ag.
2. *Echinus norvegicus*, Düben and Koren.
3. *Psammechinus miliaris* (Muller), Agassiz.
4. *Spatangus purpureus* (O. F. Müller), Leske.

V.—Holothuroidea.

1. *Thyone fusus* (O. F. M.), Agassiz.
2. *Holothuria tremula*, Gunner.

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* By Professor M'Intosh, F.R.S.

† By W. Percy Sladen.

ON THE POLYZOA.*

Forty-two species of Polyzoa and three varieties were collected on this Expedition, namely:—

Membranipora catenularia.
,, *trifolium.*
,, *dumerilii.*
,, *flemingii.*
,, *minax.*
Microporella ciliata.
Porina borealis.
Schizoporella unicornis.
,, *linearis.*
,, ,, var. *hastata.*
Mastigophora dutertrei, var. a.
Rynchopora bispinosa.
Lepralia polita.
Porella concinna, var. *gracilis.*
,, *compressa.*
Smittia landsborovii, var. *porifera.*
,, *reticulata.*
,, *trispinosa.*
Mucronella peachii.
,, ,, var. *octodentata.*
,, *variolosa.*
,, *abyssicola.*
,, *microstoma.*
Palmicellaria skenei.
,, ,, var. *bicornis.*
Retepora beaniana.
,, *couchii.*
Cellepora ramulosa.
,, *avicularis.*
,, *armata.*
Crisia (?), sp.
Stomatopora major.
,, *johnstoni.*
Idmonea serpens.
,, *atlantica.*
Diastopora patina.
,, *obelia.*
Hornera lichenoides.
,, *violacea.*
Lichenopora hispida.
Domopora stellata.
Alcyonidium mamillatum.
,, *albidum.*
Arachnidium fibrosum.
Barentsia nodosa.

About half of these species have been found, generally distributed, round the British coasts, and the other half have been found, but rarely. One, a Crisia, unfortunately, a small solitary specimen, though like the British species of *Crisia eburnea*, in the form of zœcia and œcia, has several branches to an internode, and bears the œcia higher up the branch than is usual with *C. eburnea.*

Taking the rarer species, eight have only hitherto been recorded from Shetland. These are:—

Membranipora minax.
,, *trifolium.*
Porina borealis.
Mucronella abyssicola.
Mucronella microstoma.
,, *peachii*, var. *octodentata.*
Hornera violacea.
Domopora stellata.

* By Miss L. R. Thornely.

Four only from the north of Scotland :—

Lepralia polita.
Palmicellaria skenei, var. *bicornis.*
Idmonea atlantica.
Hornera lichenoides.

One, *Smittia landsborovii*, var. *porifera*, only from South Devon.

The following, though more widely distributed, are not common :—

Schizoporella linearis, var. *hastata.*
Rynchopora bispinosa.
Porella compressa.
,, *concinna*, var. *gracilis.*
Palmicellaria skenei.
Retepora couchii.
Cellepora armata.
Alcyonidium albidum.
Barentsia nodosa.

Of the whole collection, those that have not been recorded yet from the coasts of Ireland are eighteen, namely :—

Membranipora catenularia.
,, *minax.*
,, *trifolium.*
Porina borealis.
Schizoporella linearis, var. *hastata.*
Rynchopora bispinosa.
Lepralia polita.
Porella concinna, var. *gracilis.*
Smittia landsborovii, var. *porifera.*
Mucronella peachii, var. *octodentata.*
,, *abyssicola.*
,, *microstoma.*
Palmicellaria skenei, var. *bicornis.*
Idmonea atlantica.
Hornera violacea.
Alcyonidium mamillatum.
,, *albidum.*
Arachnidium fibrosum.

The specimens are many of them very fine, both the colonies, and the cells in the colonies. A colony of *Retepora beaniana* exceeds the finest specimens recorded by Hincks by $\frac{3}{4}$ of an inch, of *Hornera lichenoides* by $\frac{1}{2}$ an inch, of *Idmonea atlantica* by $\frac{1}{8}$ of an inch, and a colony of *Porella compressa* 3 inches by 3 inches is equal to what he calls a fine specimen.

Some forms are evidently very plentiful, notably *Porella compressa*, *Retepora beaniana*; *Diastopora obelia*, which covers some of the stems of *Porella compressa*, while there being only one, or at most two examples of many, leaves the impression that there may be many undiscovered rarer forms around Rockall Bank that the dredge has passed over. Some of the specimens being old and encrusted were difficult to determine. Miss Jelly has kindly assisted me with these forms.

ON THE HYDROZOA.*

Garveia nutans.
Tubularia indivisa.
Campanularia raridentata.
Calycella fastigiata.
Cuspidella grandis.

All these specimens are already on record, as found on the coast of Ireland. *Vide* Mr. Duerden's Paper "On Hydroids of the Irish Coast," Proc. Royal Dublin Society, vol. viii. (N. S.), p. 405.

Stylaster sanguineus. Fine fresh specimens.

ON THE ACTINOZOA.†

Zoantharia.

Two bottles contained numerous specimens of Zoantheæ, one dredged June 15, and the other June 16, and a small colony of the same, in a tube, June 15. Another tube contained a very small actinian from tow-nets, June 6, 1896. As no notes were taken of this, or, indeed, of any of the specimens, when alive, no attempt has been made to investigate this, probably, immature form, since a determination of it could never be certain.

The examination of the Zoantheæ was very tedious, on account of the incrustations, and it has taken an amount of time merely to report that the Expedition collected numerous specimens of *Parazoanthus anguicoma* (Norman). Apparently, all the colonies were growing on sponges. There is nothing to add to the description of the species in the "Revision of the British Actiniæ: Part II., The Zoantheæ," Trans. Royal Dublin Soc., vol. iv. (N. S.), 1891, p. 656. Both elongated and button-like forms occurred.

Madreporiaria.

Lophohelia prolifera.
Flabellum distinctum.

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* By Miss L. R. Thornely.

† By A. C. Haddon, D.Sc., Professor of Zoology, Royal College of Science, Dublin.

ON THE SPONGIDA.*

Before entering on the description of the sponges collected on and near Rockall during the Expedition, it is my pleasant duty to thank the Royal Irish Academy for having placed this interesting collection in my hands for examination.

As all the specimens were preserved in methylated spirits, which macerates, and to a great extent destroys the soft parts of sponges, only their skeleton and external shape could be studied. It has therefore been impossible for me to give more than merely systematic descriptions of them.

The collection comprises *seven* species, three of which appear to be new to science, whilst the other four have already been described. These four have been obtained near the coasts of Great Britain, and the islands adjacent in the north. For this reason, and also because the new species are allied to British sponges, the Rockall sponge-fauna may be considered as very similar to the British. Too little is known of the sponge-fauna of Iceland, Greenland, and the northern part of the Atlantic coast of the United States to enable one to trace any particular affinity between the Rockall sponges and the sponges of those coasts.

Of the seven Rockall sponge species, two are Tetractinellida, and five Monaxonida. The family Pachastrellidæ is represented by the new species *Pachastrella stylifera*; the family Tetillidæ by the well known *Craniella cranium*, O. F. Müller; the family Axinellidæ by the new species *Thrinacophora microdragma*, *Phakellia ventilabrum*, Johnston, and *Phakellia robusta*, Bowerbank; the family Heterorrhaphidæ by the new species *Gellius styliferus*; and the family Desmacidonidae by *Esperella lingua*, Bowerbank.

Pachastrella stylifera, n. sp.

There are several more or less fragmentary specimens of a sponge in the collection which is most closely allied to *Normania crassa*, Bowerbank (Mon. Brit. Spong., vol. iii., p. 258, pl. 81) = *Poecillastra compressa*, Sollas ("'Challenger,' Tetractinellida," p. 98), but distinguished from this and other species of Poecillastra (*sensu*, Sollas), by the presence of large styles. Assuming that the Styles are really absent in *Poecillastra compressa* (they could scarcely have escaped Bowerbank and Sollas if they were present in that species), I establish for these Rockall sponges a new species with the specific name *stylifera*, in which their distinguishing peculiarity is expressed. Since I have united Poecillastra, Sollas, with Pachastrella, O. Schmidt ("Tetractinelliden der Adria," pp. 86, 91, 95), this new sponge receives the name *Pachastrella stylifera*.

One of the specimens is a fragment of a plate only 7 mm. thick, with a free sharp margin; the others are lamellæ 15 mm. thick. One side of the plate is covered by oscules which are very regularly scattered, uniformly about 6 mm. apart, and 1·5 mm. wide in the thick specimens, but decreasing in size and increasing in number towards the free margin in the thin specimen. On the opposite side no larger openings are to be seen. Oscular tubes, equal in width to the oscules, traverse the plate transversely, and extending beyond the middle of it

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in some cases nearly reaching the opposite side. There is no cortex, and the whole sponge is traversed throughout by fairly wide canals.

The skeleton consists of large smooth amphioxes, styles, triaenes, small spined amphioxes, chelotropes, short-spined spirasters and long-spined spirasters. The three first-named forms of spicules can be considered as megascleres, and the four last-named as microscleres. The large smooth amphioxes and the styles are radiately arranged, and extend, partly isolated, partly united, in loose bundles, from the base of attachment through the middle of the plate towards the free margin, giving off branches to the two faces which curve outwards in a plumose fashion, and abut nearly vertically on the surface. The large smooth amphioxes greatly exceed the styles in number. The triaenes, which are rather scarce, are confined, as is usual, to the surface where they extend their lateral branches tangentially, while the shaft lies radially and points inwards. The four kinds of spicules which I consider as microscleres are very numerous, and scattered in dense masses throughout the sponge. On the surface a slight accumulation of the short-spined spirasters is met with.

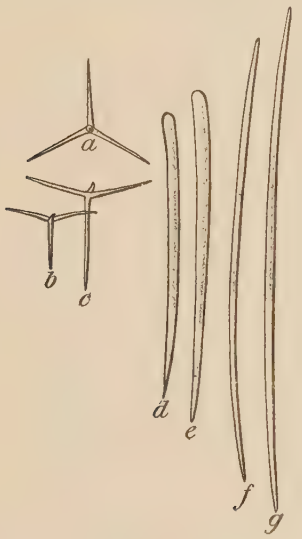

Fig. 1.—Megascleres of *Pachastrella stylifera*. × 30.

a, Orthotriaen, seen from above.
b, *c*, ,, ,, the side.
d, *e*, Styles.
f, *g*, Amphioxes.

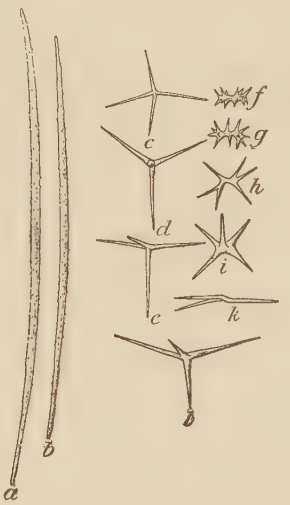

Fig. 2.—Microscleres of *Pachastrella stylifera*. × 300.

a, *b*, . Thorny Amphioxes.
c, *d*, *e*, *l*, Chelotropes.
f, *g*, . Small, stout Spirasters, with numerous rays.
h, *i*, *k*, . Large, slender Spirasters (few rays).

The *large, smooth Amphioxes* (fig. 1, *f*, *g*) are 2–2·3 mm. long, and in the middle 0·03–0·045 mm. thick, slightly curved and gradually attenuated towards the two equal and not very sharply-pointed ends.

The *Styles* (fig. 1, *d*, *e*), are 1·3–1·5 mm. long, at the rounded end 0·05–0·07 mm. thick, slightly curved and tapering gradually to the other sharply-pointed end.

The *Triaenes* (fig. 1, *a*, *b*, *c*) are *Orthotriaenes*, with nearly straight or slightly-curved lateral rays. The angle between these and the shaft is about 110°. The shaft is straight, conical, and sharply-pointed. The lateral rays are 0·2-0·3; the shaft is 0·23–0·4 mm. long; rays and shaft are about 0·02 mm. thick at the base. The axial threads are in most triaenes remarkably stout.

The *small, spined Amphioxes* (fig. 2, *a*, *b*) are 0·18-0·22 mm. long, and in the middle 0·0035–0·004 mm. thick, slightly curved and gradually attenuated towards the two equal and not very sharply-pointed ends. The surface of the spicule is covered with very small and distant spines.

The *Chelotropes* (fig. 2, *c*, *d*, *e*, *l*) are partly regular, similar to the lines connecting the centre of a Tetraaeder with its corners (fig. 2, *c*, *l*), partly more triaen-like, showing a distinction between a shaft and lateral rays (fig. 2, *d*, *e*). The rays are 0·023–0·033 mm. long, at the base 0·001–0·003 mm. thick, straight, conical, and sharp-pointed.

The *short-spined Spirasters* (fig. 2, *f*, *g*) are 0·015–0·02 mm. long, and have fairly numerous, usually 12 to 15, stout conical spines, 0·005 mm. long.

The *long-spined Spirasters* (fig. 2, *h*, *i*, *k*) have a maximal diameter of 0·03–0·04 mm., a very short axis, and 3 to 6 straight, conical, slender spines, 0·01–0·02 mm. long.

The specimens were collected on Rockall Bank in a depth of 60 fathoms, and 16 miles south of Rockall in a depth of 120 fathoms.

Craniella cranium, O. F. Müller, 1789.

Alcyonium cranium, O. F. Müller, "Zoologia Danica," Pl. 85.

Of this well-known sponge, which has already been found in many North Atlantic localities, there are several semispherical specimens, the largest of which measures 22 mm. in diameter. Some (or all?) of the specimens grew on other sponges; a case of Symbiosis also recorded by Bowerbank ("Monograph of British Sponges," vol. iii., pl. 14, p. 35).

The spicule measurements are in harmony with those given by Sollas ("'Challenger' Tetractinellida," pp. 51, 52), only some of the sigmes are somewhat larger than the largest mentioned by him. These are 0·015 mm. long and about 0·0005 mm. thick.

Attached to the outer surface of one of the specimens are a few spherical *gemmules* covered with a dense fur composed of short, radially arranged protriaens protruding a considerable distance beyond the surface.

The specimens were collected on Rockall Bank, in a depth of 60 fathoms.

Thrinacophora microdragma, n. sp.

There are numerous fine specimens of a sponge in the collection which obviously belong to Ridley's genus Thrinacophora, but which is clearly distinguished from the other species of this genus by its external shape and the smallness of its spicules and dragmes. To this peculiarity the specific name refers.

All the specimens have a short peduncle, with circular transverse section, which in the largest attains a diameter of 11 mm. From the upper end of this peduncle, which is not at

all, or only slightly, longer than thick, a frondose lamella arises, which forms a cup or a fan, or a shape intermediate between these. The free upper margin of the frondose lamella is more or less deeply incised and divided into lobose parts. Some of the incisions may reach down to the base of attachment on the peduncle. The largest of the specimens is fanshaped, the fan being 140 mm. high, 160 mm. broad, and at the base 4–5 mm. thick; towards the margin it gradually thins out to a thickness of only 2–3 mm. The marginal parts of the smaller specimens have the same thickness, but their basal parts are thinner, the degree of thinning out being the same in all specimens. The surfaces of the peduncle and lamellæ are smooth, but pierced by numerous circular, regularly distributed holes, which are at the base about 1–2 mm. apart, and 0·4–0·5 mm. wide. Towards the margin they are a little smaller and closer together. There is no difference in the structure of the two faces of the lamella. In some of the specimens a network of deep and narrow furrows is observed on the surface. I imagine that these furrows have been produced by the contracting action of the spirit in which the specimens are preserved.

The skeleton consists of amphioxes, styles, and orthodragmes. The amphioxes and styles form loose bundles, rising from the peduncle and extending through the middle of the lamellæ radially towards their margin. These bundles give off slender branches, curved in a plumose fashion, so as to abut vertically on the faces of the fronds. The branches are connected by numerous transversely situated spicules in such a manner that a sort of a network, with quadratic meshes, which have about the same width as the length of the spicules, is formed. However, this network is by no means regular, nor always clearly defined; often the spicules appear scattered pretty irregularly. Tufts of spicules, similar to those forming the inner skeleton, are met with on the surface in regular arrangement, each of the branches of spicule bundles being crowned by such a tuft. The orthodragmes are scattered throughout the sponge, but more numerous on the surface than in the interior; they are often arranged in clusters.

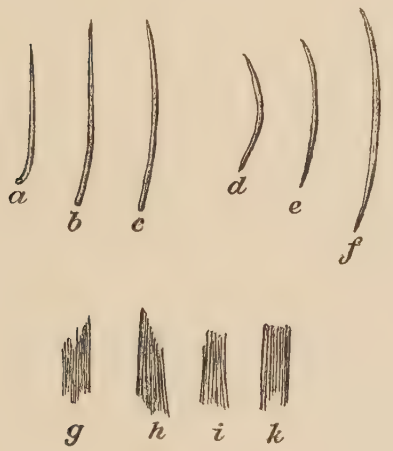

Fig. 3.—Spicules of *Thrinacophora microdragma*.

a, *b*, *c*, . . Styles. × 30.
d, *e*, *f*, . . Amphioxes. × 30.
g, *h*, *i*, *k*, . Orthodragmes. × 300.

The *Amphioxes* (fig. 3, *d*, *e*, *f*) are sharp-pointed and strongly curved, some nearly angularly bent in the middle (fig. 3, *d*), 0·25–0·5 mm. long, and 0·01–0·015 mm. thick.

The *Styles* (fig. 3, *a*, *b*, *c*) are conical, the blunt end being their thickest part, and sharp-pointed at one end. Sometimes the rounded end appears slightly inflated, so that the spicule assumes a subtylostyle shape. The styles are slightly or strongly curved, the curvature being always greatest near the blunt end (fig. 3 *a*). They measure 0·3–0·6 mm. in length, and are 0·012–0·016 mm. thick.

The *Orthodragmes* (fig. 3, *g*, *h*, *i*, *k*) are flattened, in band-shaped bundles of slender knitting-needle-like spicules. These bundles measure 0·015–0·02 mm. in length and 0·005–0·006 mm. in width.

Besides these spicules I have found *one* style with a bifurcated end. This is particularly interesting if we take into consideration that another species of this genus, *T. funiformis*, possesses spicules terminally divided into several branchlets or spines. The spicule observed by me is a diaen, with lateral blunt rays. It might be considered as an atavistic abnormity.

Besides this, I have observed a few sigmes. These may be foreign ; but, if they should be proper to the sponge, I would expect that similar sigmes would also be found in the other species ; for they may, on account of their scarcity, have been overlooked, or considered as foreign, and not mentioned.

In one case I saw the knitting-needle-like elements of the dragmes arranged radially, so as to form an euaster.

All the specimens were collected 16 miles south of Rockall Bank, in a depth of 120 fathoms.

Phakellia ventilabrum, Johnston, 1842.

Halichondria ventilabrum, Johnston, "History of British Sponges, etc.," p. 107.

About half of all the specimens of sponges collected belong to this species which has already been carefully described by Bowerbank ("Monograph of British Sponges," vol. i., p. 186 ; vol. ii., p. 122 ; vol. iii., pl. xxii., p. 57). Ridley and Dendy ("'Challenger,' Monaxonida," p. 170) have united this species with *Phakellia robusta*, Bowerbank. In the Rockall collection, not only *P. ventilabrum*, but also *P. robusta* is represented, and according to this material the two species are certainly distinct ; the vermiform spicules of the specimens referable to *P. ventilabrum* being amphistrongyles, those referable to *P. robusta*, amphioxes.

The Rockall specimens of *Phakellia ventilabrum* are short, pedunculate, fan- or cup-shaped, frondose, with deep marginal incisions. The fronds are on an average 3 mm. thick—thinner at the margin, thicker at the base—and attain a height of 100–150 mm. On many of them a Polythoa lives symbiotically. The spicules are vermiform amphistrongyles and styles. The *vermiform amphistrongyles* are more or less irregularly bent, some so much so as to form more than a semicircle. The chord connecting their truncated ends is 0·5–0·85 mm. long, and the spicules are 0·016–0·018 mm. thick. The *styles* are conical, slightly curved near the blunt end, 0·4–0·6 mm. long, and 0·01–0·014 mm. thick. There are *no* amphioxes.

The specimens have been dredged on Rockall Bank in a depth of 60 fathoms, and 16 miles south of Rockall in a depth of 120 fathoms.

Phakellia robusta, Bowerbank, 1866.

"Monograph of British Sponges," vol. ii., p. 120.

There are only a few fragmentary specimens of this species in the collection. They are frondose, 7 mm. thick, and attain a height of 80 mm. The sponge lamella is folded along

lines radiating from the base of attachment. The margin is rounded, and divided by small incisions into lobose parts. Some of these show indications of growing out into cylindrical digitate processes. This sponge is very much harder than *P. ventilabrum*, but like the latter partly overgrown at the base with Polythoa.

The spicules are vermiform amphioxes and styles. The *vermiform amphioxes* are irregularly, but not nearly so strongly, bent as the vermiform amphistrongyles of *P. ventilabrum*. They are 1–1·2 mm. long, in the middle 0·02–0·03 mm. thick, and very sharply pointed. The styles are only slightly curved, 1·4–1·6 mm. long, and 0·02–0·025 mm. thick. There are no amphistrongyles.

All the specimens have been collected on Rockall Bank in a depth of 60 fathoms.

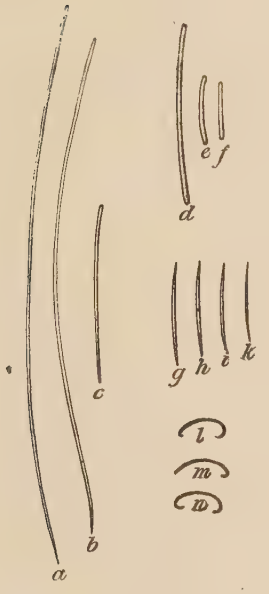

Fig. 4.—Spicules of *Gellius styliferus*.

a, *b*, *c*, Styles × 30.
d, *e*, *f*, Amphistrongyles × 30.
g, *h*, *i*, Stout Amphioxes × 30.
k, . . Slender Amphiax × 30.
l, *m*, *n*, Sigmes × 300.

Gellius styliferus, n. sp.

Hitherto only sponges with exclusively diactinal megascleres have been placed in the genus Gellius (Ridley and Dendy, "'Challenger' Monaxonida," p. 37; "Lindenfeld, Das System der Spongien," p. 408). If I here describe a sponge with both diactinal and monactinal spicules as a species of Gellius, I do so because (1) it agrees in every other respect with the species formerly described as Gellius, chiefly with *G. calyx*, Ridley and Dendy; (2) because the monactinal spicules, the styles, which it possesses are very scarce; and (3) because there is only a single, small, fragmentary specimen of it at my disposal, and I hardly like to establish a new genus on so insufficient a foundation. In future, when more is known about this and allied species, it will probably become necessary to establish a new genus for their reception.

The specimen of this species in the Rockall collection is a fragment of a probably erect, cylindrical sponge 25 mm. in diameter. The surface is smooth. The interior is rendered very lacunose by the presence of numerous wide longitudinal canals in the axis of the sponge.

The skeleton consists of styles, amphioxes, amphistrongyles, and sigmes. The amphioxes and sigmes are very numerous, the amphistrongyles and styles very scarce. Loose fibres composed chiefly of the amphioxes, with a few styles and amphistrongyles interspersed, extend longitudinally through the sponge. These "main fibres" give off very indistinct branches composed of loose spicules, the interstices between which are filled up by other loose, mostly longitudinally disposed spicules. On the surface a network of tangential spicules, single or forming small bundles of two to four, are met with. This dermal skeleton consists entirely of amphioxes. The sigmes are scattered throughout the sponge, apparently in the canal walls; they are most numerous on the outer surface.

The *Styles* (fig. 4, *a*, *b*, *c*.) are curved, the more so the longer they are. They are simply rounded off at one end and not very sharply pointed at the other, 0·8–2·5 mm. long, and in their upper cylindrical part near the blunt end 0·02–0·024 mm. thick.

The *Amphistrongyles* (fig. 4, *d*, *e*, *f*) are straight or slightly curved, simply rounded off at each end, of perfectly uniform thickness throughout, 0·25–0·8 mm. long, and 0·013–0·02 mm. thick, the shorter ones often being thicker than the longest.

The *amphioxes* are of two kinds:—*Stout amphioxes* (fig. 4, *g*, *h*, *i*) forming the bulk of the skeleton, and *slender amphioxes* (fig. 4, *k*) scattered in between the former. It is possible that the slender amphioxes may be young stages of the stout ones. I here describe them as distinct, because no intermediate forms, which would support that view, have been met with.

The *Stout Amphioxes* (fig. 4, *g*, *h*, *i*) are slightly curved, sharp pointed, 0·4–0·47 mm. long, and in the middle 0·014–0·017 mm. thick.

The *Slender Amphioxes* (fig. 4, *k*) are slightly curved, sharp pointed, about 0·36 mm. long, and 0·008 mm. thick.

The *Sigmes* (fig. 4, *l*, *m*, *n*) are slender, spirally twisted, double hooks, 0·02–0·25 mm. long.

This sponge was dredged on Rockall Bank in a depth of 60 fathoms.

Esperella lingua, Bowerbank, 1866.

Hymeniacidon lingua, Bowerbank, "Monograph of British Sponges," p. 187.

Although the Rockall specimens of this sponge possess orthodragmes, which were not described by Bowerbank as occurring in his *Hymeniacidon lingua*, I place them in this species (1) because they agree in all other respects with the description of that species given by Bowerbank ("Monograph of British Sponges," vol. i., pl. 6, figs. 144–147; pl. 18, fig. 297; vol. ii., p. 187; vol. iii., pp. 119, 287, pl. 47, fig. 8; pl. 77, figs. 1–6); and (2) because it is known (Ridley and Dendy, "'Challenger' Monaxonida," p. 66) that Bowerbank has, in another similar case, omitted to mention the dragmes.

Among the Rockall sponges there are specimens of this species from depths of 60 and of 120 fathoms. The former are fragments of a sponge possessing, apparently, lobose, cylindrical branches 10–15 mm. thick. The latter are much larger, lobose, massive, erect, and attain a height of 240 mm., and a maximum horizontal diameter of 80 mm.

The spiculation of the Rockall specimens is the following (the dimensions given are averages):—*Large style*, 0·7 × 0·014 mm.; *slender style*, 0·37 × 0·003 mm.; *large anisochel* (mostly in rosettes), 0·09 mm. long; *small anisochel* (scattered), 0·04 mm. long; *sigme*, 0·03 mm. long; *orthodragme*, 0·07 × 0·027 mm.

The specimens were obtained on Rockall Bank in a depth of 60 fathoms, and 16 miles south of Rockall in a depth of 120 fathoms.

ON ROCKALL AND ITS PREVIOUS HISTORY.*

Introduction.

In or about 1864, Mr. G. E. Roberts, Clerk to the Geological Society (1860–65), and formerly of Kidderminster, gave me a small specimen of granite, labelled "Rockall: Captain Basil Hall," without any further information that I can remember. Put away carefully, it was lost sight of for several years, but when the specimen was at last found it was given to Prof. Dr. J. W. Judd, into whose line of research its examination most appropriately falls. On the condition that I should compile some Notes on Rockall, he undertook to study this very rare specimen.

Rockall, a sharp-pointed and nearly conical islet in the North Atlantic, had long been known to seafaring men, but its exact position was determined in 1810 by H.M.S. "Endymion," (Captain Capel). Basil Hall, then Lieutenant, and T. Harvey, Master, examined the rock; and a specimen preserved ever since that time, labelled "Rockall, Captain Basil Hall," has now been examined by Prof. Judd.

In 1819, H.M.SS. "Hecla" and "Griper" sighted the islet, as recorded by Surgeon A. Fisher in 1821.

In 1860, H.M.S. "Bulldog" (Captain Sir L. M'Clintock) made some soundings near Rockall, as mentioned by Dr. G. C. Wallich in 1862.

In 1862, H.M.S. "Porcupine," R. Hoskyn, Master, visited the rock. The difficulty of access prevented anyone but the boatswain (Mr. Johns) from landing. He managed to knock off a few specimens. Some were preserved by Lieutenant, now Staff-Captain, G. H. Inskip, who has kindly lent a specimen; and some were sent to Ireland, one of which Prof. Anderson, of Queen's College, Galway, has kindly lent from the College Museum. In 1869, H.M.S. "Porcupine" (Captain Calver) was again near the islet; but no one landed.

Detailed Particulars of the several published Notices of Rockall; and Information communicated in Letters.

1698. M. Martin: "A late Voyage to St. Kilda," 1698; [reprinted in Pinkerton's "General Collection of Voyages and Travels," vol. iii., 1809, p, 703]. "Rokal, a small rock, sixty leagues to the westward of St. Kilda, the inhabitants of which call it Rokabarra."

1727–51. Hakluyt Society, volume for MDCCLII. "The Geography of Hudson Bay." Edited by John Barrow. Being the remarks of Captain N. Coates, in many voyages to that locality, between the years 1727 and 1751 (p. 7.)

"Rokel is a solitary island in latitude 57° 38′ N.; longitude west from Hoy head, 10° 30′ W.

Compiled by Professor T. Rupert Jones, F.R.S., F.G.S.

"Rokele is a piramid not unlike the Stack, but higher and bigger, and white from the same cause; and I had no ground at eighty fathom on the N.W. side, at the distance of a mile and a-half, and I made E. 10° N. erly from this rock to Hoy heade."

1812. Purdy's "Memoir of a Chart of the Atlantic" (1812, p. 219). I am informed by Mr. Miller Christy, F.L.S., there is a view of the rock* (probably the first ever published), together with the statement that it was visited by Mr. J. Harvey (master) and the other officers of H.M.S. frigate, "Endymion," (commander, the Hon. T. B. Capel), on July 8, 1810.

1819. J. MacCulloch: "A description of the Western Isles of Scotland": 3 vols., 1819.

"St. Kilda, solitary in structure (trappean) as it is in position, since the nearest rocks on the east side consist of gneiss, and the first we meet with on the west, Rockall, is formed of granite"; vol. ii., p. 58,

1821. Surgeon Alexander Fisher, R.N.: "Journal of the Voyage of Discovery to the Arctic Regions in His Majesty's Ships 'Hecla' and 'Griper,' 1819 and 1820" (4th edition, 1821), refers to Rockall being "the summit of a very extensive submarine mountain," and presenting, at the distance of four or five leagues, the appearance of a ship under sail. Search was made at the same time for the 'sunken land of Busse,' but unsuccessfully, at the place where Lieutenant Pickersgill . . . struck soundings with a line of 320 fathoms; . . . but with 1220 fathoms of line out we found no bottom." It is added that, perhaps, the latter had mistaken the longitude of the place.

1842. Captain Basil Hall, R.N.: "Fragments of Voyages and Travels"†; new edition, 1842, p. 143. The author relates the circumstances of his first acquaintance with Rockall. Between 1809 and 1812 he was lieutenant‡ in the "Endymion," under the command of the Hon. Thomas Bladen Capel; and, cruising off the north coast of Ireland, the frigate one day had been chasing what was thought to be a brig, with white sails aloft, while the lower sails were dark. This was Rockall, often mistaken for a vessel by sailors at sea; and it was found to consist of granite, with a snow-white coating at top, the abode of myriads of sea-fowl. The projecting rock itself (Rockall) "is only 70 feet high, and not more than 100 yards in circumference"; a mere speck on the surface of the water on which it seems to float. "It lies at the distance of no fewer than 184 miles, very nearly due west of St. Kilda, the remotest of the Hebrides; 290 from the nearest part of the main coast of Scotland; and 260 from the north of Ireland." It is, adds Captain B. Hall, "at a greater distance from the mainland

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* Of a tall, acute, sugar-loaf shape, with rugged sides. Much more sharply conical than any other published figure of the Rock.

† Originally published in three series, (each in 3 small volumes), 1831–34. A vignette on the title-page of vol. iii., of the 2nd Edition, 1832 (Cadell, Edinburgh), represents a dark, steep-sided mass of rock, with a white conical apex, and gives a somewhat better notion of a ship in full sail, than most of the other published figures. It is very similar to the eighth sketch (view from the west at two miles), on the top of Vidal's Chart, 1831).

‡ See the "Dictionary of National Biography," vol. xxiv., 1890, pages 58, 59, where further references are given.

than, I believe, any other island, islet, or rock, of the same diminutive size, to be found in the world."

A party in two boats visited the rock,* with sketch-books, hammers, chronometers, &c. The landing was far from easy; but the return to the boats was much more difficult and tedious on account of the increasing swell against the steep and slippery rock; and then the ship was not visible, owing to a kind of illusive mist. After rowing about a while, the two boats were kept near the rock, as a fixed point; and a look-out man climbed to the top. After a time he saw a fog coming on, and down a lane in it he saw the ship. The boats having picked up the "shivering scout," rowed hard and sighted the ship; but she tacked and stood off, for those on board could see neither the boats nor the rock. So the party returned to stay by the rock, and waited until the fog rose. The ship was then again seen, and reached before the night closed in. Strange to say, the people in the boats never heard the guns which were fired every ten minutes from the vessel for five or six hours.

Doubtless, it was on the occasion of this visit to Rockall that the little specimen labelled "Rockall: Captain Basil Hall," and now the subject of Dr. Judd's research, was obtained in 1810.

1831–1863. In the Admiralty Chart No. 2870, showing the relative position of Rockall with the nearest parts of the Scotch and Irish coasts, "by Captain Vidal, R.N., in H.M.S. 'Pike,' 1831, corrected to 1863" (now out of print), the Rockall Bank is defined, by soundings of less than 200 fathoms, as irregularly oval, about 280 miles long from about N.E. to nearly S.W., about 100 miles at its broadest (northern) moiety, and narrowing away, with a curved tapering outline towards the W.S.W. It is nearly parallel with the Hebrides, and somewhat of the same shape, but it does not reach so far northwards.

Within the northern half of the Bank, and nearly parallel with its north, west, and east sides, is an irregular oblong area of shallower water, defined by soundings of less than 100 fathoms, about 100 miles long and 50 broad.† About 5 miles S. by W. is a small irregularly oval bank. In the northern half of the inner shoal rises "Rockall" itself‡ (70 feet high, and about 250 feet in circumference at the water-line), together with the low "Hasselwood" Rock covered at half-tide), both within an oval area, with 22–30 fathoms of water; and three-quarters by less than one-half mile in size. Rockall is in lat. 57° 36′ 20″ N., long. 13° 14′ 32″ W.

A small rock, "Helen's Reef,"§ with 6–12 feet of water, lies in another part of the shoal,

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* On July 8, 1810, as stated by Purdy.

† Eight figures of profiles are given at the head of the chart. The eighth sketch is placed below the seventh at the right hand of the reader; and "Hasselwood Rock" is written close by t, apparently by misadventure, for the latter is only a small half-tide rock, very different from Rockall.

‡ This portion of the bank is shown on the Admiralty Chart of the British Islands corrected to 1879, with some differences of detail as to scale and number of soundings.

§ So named after a vessel that was wrecked there.

about 1¼ miles to E.N.E. About 3½ miles N.E. of Rockall, the small "Leonidas" rock has been noted, but is doubted.

Rockall is stated, on Captain Vidal's Chart, to consist of coarse granite; and it is noted that the "compass-variations very near the Rock were such as to induce the supposition that it is highly magnetic." Possibly the subterranean mass, rather than the rock itself.*

In the inner part of the shoal, "rock," "gravel," "sand and gravel," "fine sand," and "sand with shells" are noted in the soundings. In the outer part, besides the foregoing, "fine gravel," and at one spot "shells," are noted.

1845. Memoirs, descriptive and explanatory, to accompany the Charts of the Northern Atlantic Ocean. By John Purdy, Hydrographer; ninth edition; edited by A. G. Findlay, 1845, p. 443:—

"Rokol, or Roekall. This is a large and high rock, of a conical or sugar-loaf shape; the summit, or upper part, of which is perfectly white from an immense quantity of birds' dung with which it is covered. The rock has been seen many times, but its true situation was unknown till the year 1810, when it was ascertained by Mr. T. Harvey, Master, and the other officers of the 'Endymion' frigate,† commanded by the Hon. T. B. Capel. By the observations made by these gentlemen on the 8th of July, it appeared that the longitude, per mean of 11 lunars, was 13° 30′ W., and the latitude, per meridian altitude, 57° 40′ 10″. In Captain Vidal's Chart of the western banks it is represented in 57° 35′ N. and 13° 40′ W."

"The greatest breadth, which is on the parallel 57° 30′, is 18 leagues" (p. 444).

"Mr. Richard Peacock in 1809 remarked—'This rock appears almost like a ship at a distance, and it is steep close to on the North side.'"

"Helen's Reef, N.E. of Rokol, two leagues or less; here the brigantine 'Helen,' of Dundee, struck fatally, 19th April, 1824."

1862. In Dr. G. C. Wallich's "The North-Atlantic Sea-bed, comprising a Diary of the Voyage on board H.M.S. 'Bulldog,' in 1860," this rock is mapped as rising out of the Rockall Shoal, at about 315 miles west of the Hebrides; about 440 miles N.W. of Ireland; about 750 S.S.E. of Iceland; and about 1800 miles S.E. of Greenland. The shoal or bank, irregularly oval in shape, has its greatest diameter pointing towards a little N. of the Faröe Islands, which are about 600 miles distant to the N.E.

Dr. Wallich discusses the relation of this shoal to the sunken, and perhaps still sinking, area, including the "sunken land of Buss," laid down on some old charts (lat. 57° 30′ N.; long. 29° 50′ W.), and another further eastward—about 50 or 60 miles N.W. of the Rockall shoal. Finding indications of a plateau partially raised above the surrounding level of the sea-bed between Greenland and the "sunken land of Buss," Dr. Wallich thinks that the above-mentioned old shoals, though discredited by some navigators,‡ may be evidence of a sinking

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* The magnetite of basalt is the chief cause of local attraction, and none is at present known in Rockall itself.

† See also *supra*.

‡ The old navigators had not such good sounding apparatus as is used by modern surveyors.

area* near the former margin of the Atlantic, near which line Rockall stands (pp. 62, &c.). The ancient boundary-line, suggested by Sir John Richardson and accepted by Edward Forbes and Godwin-Austen, is thus described by the last :† "A dotted line of the map from Newfoundland to Cape Farewell (the extreme southern point of Greenland), thence across the Atlantic by Iceland and the Faröe archipelago, represents, conjecturally, the northern limitation of the Atlantic at the time when it did not communicate with the Arctic basin."

Both Rockall and another rock in the North Atlantic Dr. Wallich mentions (page 72) as resembling a ship under sail, when seen from certain points of the compass. The other rock is the Blinde Skier, an isolated basaltic rock, 80 feet high, near Cape Rakianess, Iceland.

1863 (?). Deep-sea Soundings, West of Ireland. Mr. R. Hoskyn, Master and Surveyor, H.M.S. "Porcupine," in June, July, and August, 1862 (with Chart), pages 1–8 ; and Preliminary Notice of the Organic and Inorganic Objects obtained from the Soundings of H.M.S. "Porcupine" off the West Coast of Ireland ; by Professor William King, Queen's College, Galway, and Queen's University, Ireland, pages 1–28.

Page 3 : Hoskyn. Could not find "Brazil Rock." He suggests that a balk of timber, with barnacles and seaweed, appears like "a rock a-wash," and thus a "vigia."

Page 4 : August 14. "At noon observed Rockall, with several fishing-vessels near it. There being too much sea to do anything in the vicinity of the rocks, hove to for the night.

August 15. Got observations for lat. and long. ; found the current setting with floodtide N. by E., 0·8 knot. The weather having become fine, with only a moderate swell, sent a boat with a party to land on the rock ; but the sea broke so heavily round it, that the officer in command thought it would be imprudent for them to do so. One of the party, Mr. Johns (the boatswain), succeeded in getting a footing, but not at the part where the summit is accessible . . . is composed of coarse granite.‡

Captain G. H. Inskip informs me that he was with the "Porcupine" surveying ship, in 1862, when she touched at Rockall. Only the boatswain was able to land, and the sounding-lead was thrown to him to break off some specimens : these he got all at one place—perhaps four or five pieces ; and, wrapping them in either his handkerchief or, more probably, his neckerchief, he threw them into the boat. One of these pieces (or a part of one) Captain Inskip let David Forbes have by hand of Gwyn Jeffreys.§

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* Wallich argues that the presence of living organisms of shallow-water kinds at great depths shows that they have been gradually accustomed to bathymetric changes (pages 67, 69, 149, &c.). Elsewhere he suggests that the presence of some gravels occurring at great depths points, not merely to possible deposition from ice-bergs, but to their former existence in shallows, which have gradually been let down by the subsidence of the sea-bed.

† "The Natural History of the European Seas" : by the late Edward Forbes. Edited and continued by Robert Godwin-Austen, 1869, p. 286.

‡ "Specimens have been sent to various museums in Ireland" : supposed to have been the Geological Survey of Ireland, the Museum of Belfast, and Queen's College, Galway.

§ "If you could trace the piece of rock I let Professor Forbes have (through Gwyn Jeffreys),

Mr. R. H. Scott, F.R.S., informs me that he received a piece of the Rockall "granite" from Mr. W. Harte, formerly of Derry, who had it from Captain Hoskyn, of the "Porcupine." Mr. Scott, in 1866, deposited this specimen either in the Museum of the Royal Dublin Society or in that of Trinity College, Dublin.

1869. J. Gwyn Jeffreys, on the "Nature of the Sea-bed," *Nature*, vol. i., No. 6, December 9, 1869, p. 167, states that among the "pebbles and gravel," from 1215–1476 fathoms, "were several fragments of true volcanic lava," probably from Iceland, or Jan Meyen.

David Forbes' Report on these and on the specimen from Rockall ("for which I am indebted to Staff-Commander Inskip, who procured it in the 'Porcupine' surveying expedition of 1862") accompanies the communication made by J. G. Jeffreys to the Royal Society in 1869.

1870. Proceedings Royal Society, vol. xviii., 1870, p. 492. Appendix to J. Gwyn Jeffreys' Paper on the Scientific Exploration of the Deep Sea. David Forbes' "Notes on Specimens of the Bottom collected during the first Cruise of the 'Porcupine' in 1869," pp. 490–492. Also the specimen referred to by J. Gwyn Jeffreys in *Nature*, vol. i., p. 167, as having been got by Staff-Commander Inskip in 1862.

David Forbes stated :—"The specimen from Rockall is not a fragment of any normal rock, but is only a breccia-form aggregate,* principally consisting of quartz, felspar, and crystals of green hornblende, held together by a siliceous cement. It has evidently been broken from the projecting edge of a fault or vein-fissure; and, although it cannot settle the matter definitely as to what rocks this islet may really be composed of, it would indicate that it most probably is a mass of hornblendic gneiss or schist, and certainly not of true volcanic origin. I may mention that it does not at all resemble any of the fragments found in the deep-sea dredgings which I have as yet examined (described at pp. 491–492).

At the same time, David Forbes described the characters of various loose stones dredged up by the "Porcupine" in 1869. See Proceedings Royal Society, vol. xviii., 1870, pp. 491, 492. No special geological value was set on such loose stones taken from the sea-bed at or near the bank.†

1870. The Proceedings of the Royal Society, vol. xviii., 1870, contains the narrative and results of the three North-Atlantic cruises of the "Porcupine" (Captain Calver), by Carpenter, Gwyn Jeffreys, and W. Thomson, in 1869, with charts. At p. 419 (First Cruise), Rockallis referred to as an "isolated and conical island, standing out of the Atlantic in lat. 57° 31′, and long. 13° 41′, at least 200 miles from the nearest land." At page 422, it is stated that, at

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you would have the other part of the specimen I ought to have, for I broke it off."—April 18th, 1896: G. H. Inskip.

The piece seen by David Forbes and the piece preserved by Captain Inskip are described by Professor Judd, at p. 48.

* Evidently it was misjudged from its weathered granular exterior, its internal structure not being microscopically examined.

† Much ballast must have been strewn about from wrecks; and ballast may be thrown out from the fishing-boats as they fill up with fish.

Station 23 (N. lat. 56° 7′, W. long. 14° 19′), near Rockall Bank (eastward of its tapering end) at 630 fathoms, the temperature was 17° above that of the surface (according to the thermometers then used), indicating the presence of a "warm sub-marine spring."

1873. C. Wyville Thomson, "The Depths of the Sea" 1873, plate ii., is the chart of the first cruise of H.M.S. "Porcupine" in 1869, with Rockall in place.

1877. The vignette given in the Map ("No. 45"), of the British Isles, in the new edition of Stieler's "Hand-atlas" is copied from one of the right-hand figures of Rockall, on Capt. Vidal's Chart (Admiralty). So also that given by Harvie-Brown and Buckley, in "A Vertebrate Fauna of the outer Hebrides."

1877. W. B. Carpenter, "The Temperature of the Deep Sea-bottom," Proceedings Royal Geographical Society, vol. xxi., No. 4. A chart of the northern portion of the Atlantic shows Rockall.

1879. In the "Scien. Proc. Royal Dublin Society, N. S., vol. 1880, Mr. W. Frazer, F.R.C.S.I., contributed a Paper (pages 173–176, plate 9), "On Hy Brasil, a traditional Island off the West Coast of Ireland, plotted in a MS. Map, written by Le Sieur Tessin, Geographer Royal to Louis XIII." This map is reproduced in plate 9, illustrating Mr. Frazer's Paper, as "A chart of the Islands and maritime coasts of Europe, in which we see the route and navigation of the Hollanders by the North of Ireland and Scotland, during the wars with the English, by the German Ocean." "It was made about the year 1640." This map comprises "Rookall" (Rockall), with indifferent outline (apparently the N. and S. ends reversed). Mr. Frazer refers, at page 174, to the lost island "Brasil," as having been much in the position now ascertained to be occupied by the "Porcupine" Bank,* and regards it as a last relic of such a subsidence as would have accounted for the disappearance of the so-called "Atlantis."

1881. Rockall is shown in place in the two maps, plates D and E., illustrating Prof. Dr. James Geikie's "Prehistoric Europe." In plate E the bank is made to partake of the elevation of the north-western European area to the extent of about 300 to 500 fathoms, in "Early Post-Glacial times." Rockall Bank is not, however, made to participate in this land-connexion with the British area, Faröe, and Iceland. It may have been exposed for probably nearly 100 miles in length, parallel to the mainland.

1886 (?). Rockall is shown in Levesseur and Kleinhaus; "Relief-map of Europe and adjacent seas."

1888. J. B. Jordan's "Contoured model of the British Isles," including the submarine plateau and surrounding area, indicates the elevation and outline of the Rockall Bank, and the deep channel at its western and south-western edges.

1888. Harvie-Brown and Buckley: "A Vertebrate Fauna of the Outer Hebrides," 1888; Rockall, pp. lxxxvii–xcii. In a corner of the plate with plan of St. Kilda, &c., is a figure of

* About 130 miles W. of Galway Bay; and about 40 miles long, by 15 wide, lying approximately N.E.–S.W. This Paper was also published in Jour. Roy. Geol. Soc. Ireland, N. S., vol. v., 1880, pp. 128–131, pl. 4.

Rockall—"184 miles nearly west of St. Kilda . . . shaped like a haystack, and is about forty feet high";—"someone else says sixty." It also refers to the Chart of the Survey by H.M.S. "Chanticleer," about 1823. Fishes—Cod, Halibut, Skate, Ling, Haddock, Saithe, and Blue Shark at Rockall Bank.

The captain of a Grimsby smack (in or before 1888), "with a line, climbed, and estimated the height of the Rock at 78 feet. The top forms a ridge, running from E. to W. The west side is almost perpendicular; and the east side slopes more gradually to the sea."—From a letter from Mr. Cursitor, of Kirkwall.

1892. An account of a voyage to Rockall was published in "Chambers' Journal," March, 1892, pp. 161–163; but in the "Annals Scot. Nat. Hist.," vol. i., 1892, p. 197, and in the "Proc. Roy. Phys. Soc., Edinburgh," vol. xiii., p. 68, this is regarded as fictional, and founded on Capt. Basil Hall's account of his visit to the Rock. Further, in a letter to the editors of the "Annals" (*loc. cit.*), the author of the paper wrote—"An imaginary description of a visit to Rockall." . . . "I never was at Rockall."

1894. In his "Great Ice-Age," 3rd edition, Dr. James Geikie, in plate xii., defines again the Iceland-Faröe Peninsula and its isthmus (see above, p. 95): and moreover projects, from the Faröe portion, a narrow strip of land in a westward direction to connect and comprise Rockall.

1896. New Sailing Directions (Admiralty), 1896, p. 739.—"At a distance 170 miles westward of the most western of these [the outlying islands of the Hebrides] is Rockall, a remarkable little rocky islet, near the north-eastern end of an extensive bank of soundings entirely separated from the 100-fathom edge of soundings of the British Islands by depths of from 1000 to 1600 fathoms.

"*Rockall*,* in lat. 57° 36′ N., long. 13° 42′ W., 70 feet in height, and about 250 feet in circumference at its base, is composed of a coarse granite, said to be of highly magnetic character. The summit of the Rock, sharp-pointed, and whitened by the deposit of sea-birds, can only be gained by an ascent on its north-eastern side; but a landing can seldom be effected, and even in the finest weather is difficult, the rock being steep on all sides. The bank on which it stands is fully 150 miles long N.E. and S.W., by about 50 miles wide within the 200-fathoms line, and about half that extent within 100-fathoms line; it is resorted to by fishing-craft at certain seasons. At a radius of 2½ miles from the rock, the depths are from 70 to 40 fathoms, though Helen's reef, presently described, is only three-quarters of a mile within that radius; and there are from 20 to 30 fathoms close up to the rock.

"*Haslewood Rock* is a small half-tide detached rock, bearing N.E. by N. 1½ cables from Rockall, with a depth of 30 fathoms water between them.

"*Helen's Reef*, bearing E. by S. 1¾ miles from Rockall, has about 6 feet over it at low water. It is so called from the fact that a vessel named 'Helen' was wrecked on it, and is very dangerous. Its position is generally shown by breakers; indeed, at low water springs, the summit of the reef has been actually seen in the trough of the seas, but towards high water,

* See Admiralty Chart, British Islands, No. 2, Scale m = 0·04 inch.

the rise being about 6 feet, and in fine weather it only breaks at long intervals. From its being small and steep, too, there is nothing to indicate the approach to it. In order to avoid it, keep Rockall well clear of a W. by N. bearing when in its vicinity."

1895–6. In his pamphlet on Rockall (1895, pages 65 and 66), Mr. Harvie-Brown gives the result of Professor Heddle's examination of a piece of rock fished up off the bank; and Professor Heddle informs me, by letter (March 24th, 1896), that in his opinion "Rockall, and the neighbouring reefs are remnants of an island of hornblendic gneiss; and that the small portion still protruding may be bound together, as it is in parts of the Long Island, by interlacing trap-veins."

1896. Mr. J. Cordeaux has liberally presented to the British Museum (Natural History), and to the Royal College of Science, London, a collection of the marine organisms which have attached themselves to the loose stones and pebbles near Rockall. These specimens he obtained lately from the Grimsby fishermen, who bring them up entangled, by the branching corals, &c., on their fishing-lines.

Concluding Remarks.

A geological examination of Rockall and its Bank, with the neighbouring rocks and shoals, throws light on the prehistoric distribution of land and water in the North Atlantic area. The north-east margin of the Atlantic, when separate from the Arctic Ocean, is now broken up into Iceland, Faröe, and Hebrides, with a deep channel between the last two groups. In this deep and narrow strait, judging from the many soundings published for these seas, the opposite margins meet much nearer at one place than elsewhere; and some small portions of its floor, now rising to about 100 fathoms below sea-level, must have been islands and peaks when the sea-bed and neighbouring lands rose to a much higher level than at present. Rockall must be the relic of a mountainous island near the north-eastern border of the Atlantic before it was connected with the Arctic. Other rocks and shoals may also indicate an outlying portion of the British area at that prehistoric time, with deep depressions intervening.

On the basis of charts and soundings, Dr. James Geikie has mapped out in his "Prehistoric Europe" (1844) a narrow isthmus connecting the northern part of the British area with a large peninsula trending north-westerly, and comprising Iceland, Faröe, &c., as the result of an elevation of the land for 400–500 fathoms, during early Post-Glacial times. Rockall itself being 70 feet high, and the Bank (as defined by the 100 fathoms line) being now about 70 miles long, and about 30 miles where widest, an elevation equal to that of Dr. J. Geikie's Iceland–Faröe peninsula would make Rockall a mountainous island, more than 3000 feet high, with an intervening channel of about 800 to 1100 fathoms. Snowdon, now 3600 feet high, would, if the elevatory movements were equal all over the region, have been 6600 feet high at that period. Rockall is scarcely near enough to the old border of the Atlantic to have formed an integral part of it unless the elevation was great enough to lay bare the intervening channel which is now from about 1300 to 1600 fathoms deep.

EXPLANATION OF PLATES IX.–XIV.

PLATE IX.†

Rockall, looking E.N.E., from a sketch by Rev. W. S. Green.

PLATE X.*

Upper Drawing.—Rockall, looking about S.W. From a sketch by Rev. W. S. Green.
Lower Drawing.—Rockall looking N.N.E. ,, ,, ,,

PLATE XI.

1. Rockall, bearing E.N.E.
2. ,, ,, N. by E.
3. ,, ,, N.E. by E.
4. Rockall, bearing N.N.W.
5. ,, ,, N.E. by N. $\frac{1}{2}$ N.
6. ,, ,, N.W. by N.

The position of the Hazelwood Rock can be seen in Nos. 1, 2, and 5. In No. 1 it is indicated by the wave breaking at the extreme left margin of the picture; in No. 2 by the line of foam a little beyond and to the right of Rockall; and in No. 5 by a long line of foam to the left of Rockall, and just beyond its circle of foam.

PLATE XII.†

Microscopic Sections of Rockallite, from Rockall. × 17. (*Vide* p. 48.)

Fig. 1.—Section from the Basil-Hall specimen.
Fig. 2.—Section from the Inskip specimen.

PLATES XIII. AND XIV.

Winds and Currents Charts (*vide* p. 63).

* The cost of this Plate has been liberally defrayed by J. A. Harvie-Brown, F.R.S.E.

† The cost of this Plate has been defrayed out of the Fund placed at the disposal of the Academy by the Trustees of the Royal Geological Society of Ireland, for the purpose of illustrating Papers on Geology and Mineralogy.

J. S. G. ad nat. pt

West, Newman & Co. Imp.

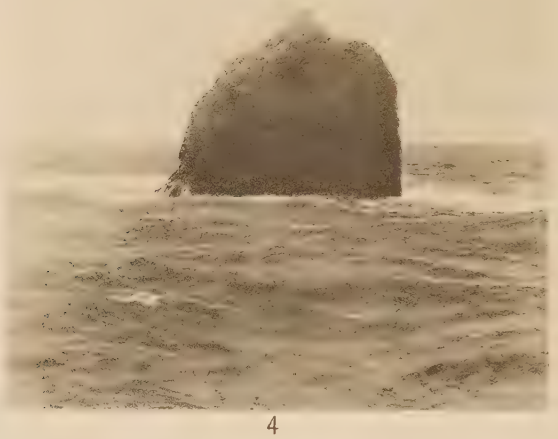
W.S. Gad nat.pt

West, Newman chrom.

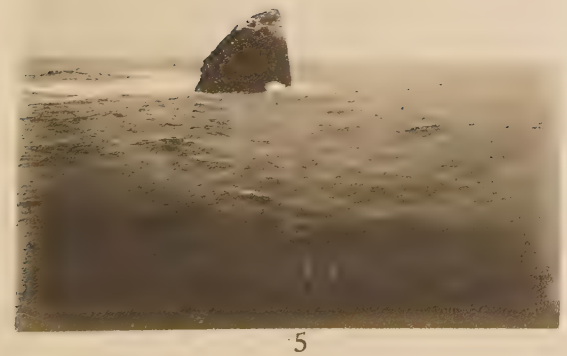
1

2

3



4



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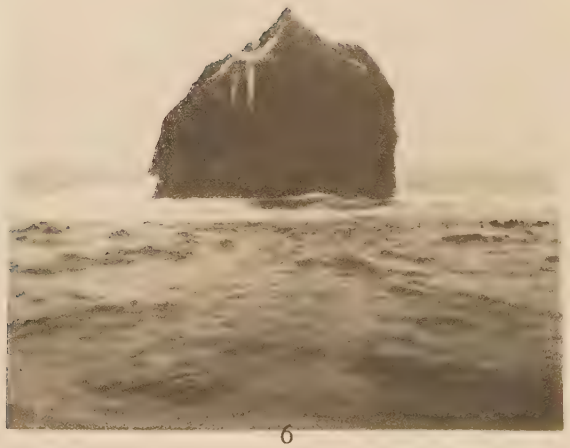


6

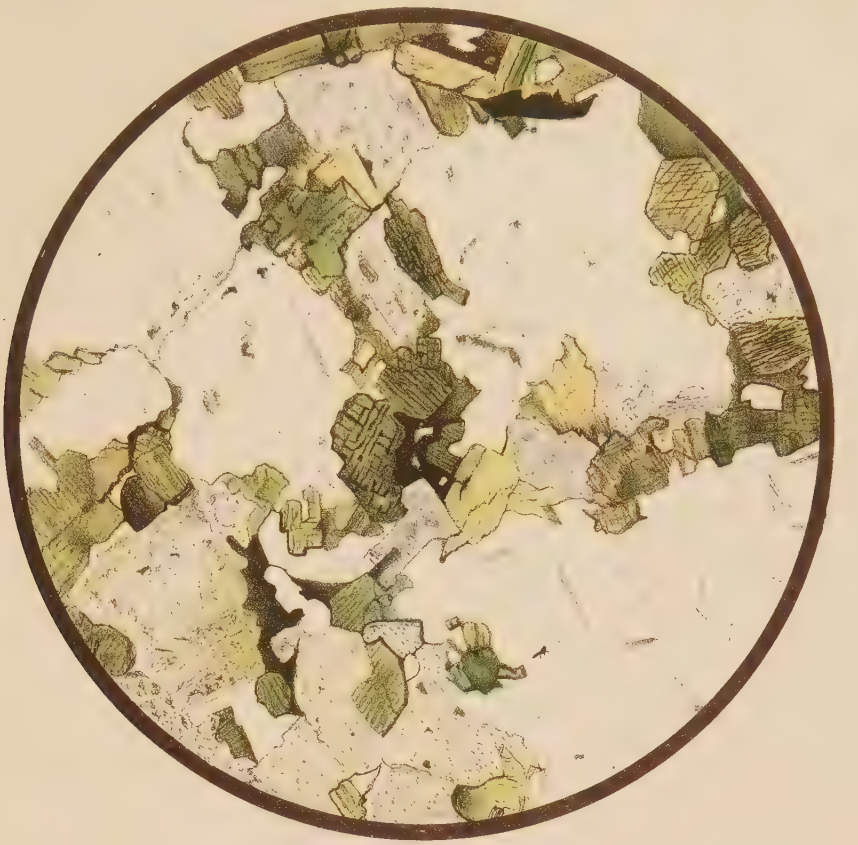
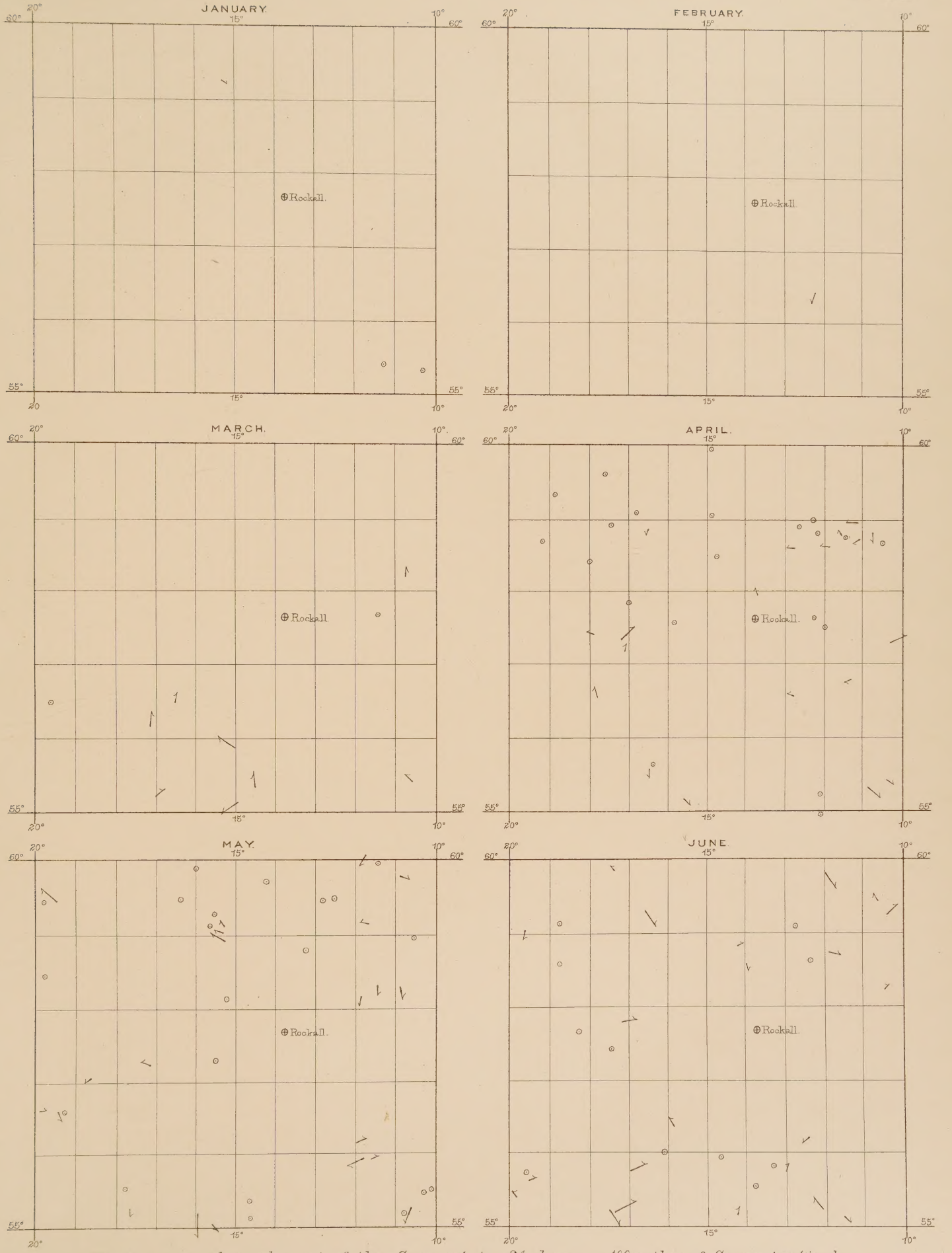


Fig. 1. ×17.

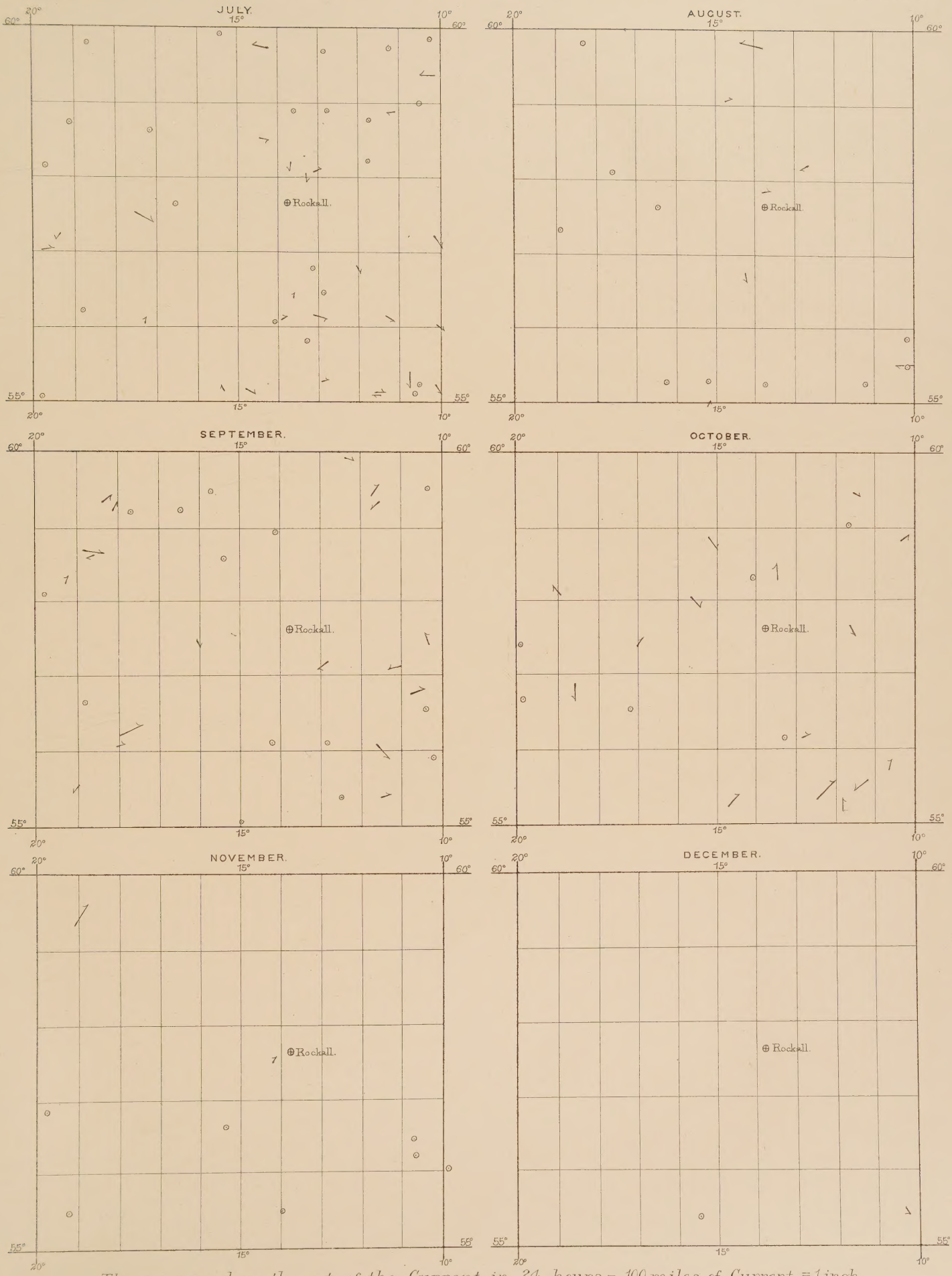
Fig. 2. ×17



The arrows show the set of the Current in 24 hours — 100 miles of Current = 1 inch.

⊙ = *No Current.*

Geo. West & Sons lith.



The arrows show the set of the Current in 24 hours – 100 miles of Current = 1 inch.

⊙ *No Current.*

Geo. West & Sons lith.